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AUTHORITY

USAAMCA Ltr, 19 Dec 1973

FUTURE WARFARE IN URBAN AREAS

5 July 1968

U.S. ARMY ADVANCED MATERIEL CONCEPTS AGENCY

3220 Duke Street
Alexandria, Virginia 22314

REPORT OF

THE FIRST

AD HOC WORKING GROUP

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ABSTRACT

The purpose of this study was to list provocative advanced materiel concepts for neutralizing or controlling a defended urban area, void of noncombatants and consisting of a high density of ordered man-made structures, subject to one or more of the following constraints: minimum time, minimum friendly casualties, minimum cost, and minimum damage to the urban area.

The study was limited to:

a. Seizure and clearance operations in which friendly forces seek to occupy the urban area.

b. Conflicts between US Army forces and similarly well-trained and organized enemy regulars.

No special attention was paid to the differences which might arise when US forces were opposed by, for example, insurgent enemy or numerically superior forces. Similarly, no attention was given to the circumstance of friendly force of counterinsurgency troops with limited numbers of US advisors.

Thirty-eight advanced materiel concepts are listed. Of these, the following five leading concepts were explored in more depth, resulting in recommendations for further action:

a. Small Controllable Air Mobility Device (WASP).

b. Observation Obstruction Foams.

c. Area Denying Foams.

d. Aerial Assault Vehicle for Urban Warfare.

e. Remote Control Expendable Ground Reconnaissance Vehicle (TURTLE).

FOREWORD

This study was authorized by the Director, Advanced Materiel Concepts Agency (AMCA), in consonance with the provisions of General Orders No. 73, Headquarters, US Army Materiel Command.

This study was conducted at AMCA, 3220 Duke Street, Alexandria, Virginia 22314, by a select group under the general guidance of Dr. Peter D. Lenn during the periods 25 through 28 March and 8 through 12 April 1968. The letter of implementation and list of participating members is included in Appendix A.

The report represents the collective judgments, conclusion, and recommendations of the first ad hoc working group. Comments to increase the usefulness of the ideas listed herein should be forwarded to the address noted above.

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SECTION I - INTRODUCTION

SECTION I - INTRODUCTION

I.1. Problem Statement.

The First Ad Hoc Working Group defined the general problem to be considered as:

> "Neutralizing or controlling a defended urban area, void of noncombatants and consisting of a high density of ordered man-made structures, subject to one or more of the following constraints: minimum time, minimum friendly casualties, minimum cost, and minimum damage to the urban area."

I.2. Scope.

The portion of the foregoing general problem which was specifically addressed by the Group was limited to seizure and clearance operations, in which friendly forces seek to occupy the urban area. Furthermore, emphasis was placed on such operations which are conducted in the absence of (or without regard to the effects upon) any noncombatant personnel within the defended urban area.

Within the above scope, consideration was limited to conflicts between US Army forces and similarly well-trained and organized enemy regulars. No special attention was paid to the differences which might arise when US forces were opposed by:

a. Insurgent enemy with limited equipment.

b. Insurgent enemy with modern and abundant equipment.

c. Vastly numerically superior enemy with limited equipment.

d. Enemy air superiority.

Similarly, no attention was given to such circumstances as:

a. Friendly force of counterinsurgency troops with limited numbers of US advisors.

b. Attack before friendly air superiority has been established.

Current programs for the development of new equipment and for the improvement of existing equipment may be largely unaffected by this study. Thus current equipment development and improvement programs were not surveyed, catalogued, or substantively discussed; it was assumed that such programs would be successfully completed. However, in a few cases

the Group examined the pertinence of an existing idea or program related to urban conflict, as an extension of the motivation and justification for such programs. These are covered in Section II and Appendix C.

Consideration of the general problem led to discussions of the nature of the target, the basic military objectives to be achieved, the relative advantages and vulnerabilities of the opposing forces, and other factors in an effort to place bounds on the scope of study. These considerations are summarized in Appendix D.

I.3. Methodology.

The Group stratified the problem in three fundamentally different ways. Studying urban conflict from three different points of view revealed relationships (and therefore concepts) which might otherwise have been missed. Urban conflict was thereby examined by means of the following analyses:

a. Special environmental properties of urban conflict, with particular emphasis on the differences between the battle environments of the city and the country.

b. Human and materiel characteristics and vulnerabilities in urban conflict.

c. New technological developments which can be expected to result in materiel items and/or operational concepts which are especially useful in urban conflict.

These examinations are described and detailed in Appendix B.

As much as analysis, the Group exercised expertise in diverse fields to attempt to reach sound technical and military judgment. None of the concepts were carried to preliminary design and none were costed, nor were quantitative effectiveness measures developed. The Group examined advanced concepts sufficiently only to advocate further action by the Army on some of them, because they appeared to offer improved capabilities at affordable costs through application of existing or achieveable levels of technology.

I.4. Advanced Materiel Concepts for Urban Warfare.

The Group listed 38 items for advanced materiel concepts and/or (new) operational doctrine that roused sufficient interest on the part of one or more members that they undertook a brief write-up of the notion. On five of these concepts, the Group recommended specific action by AMC and CDC. These action items are discussed in Section II.

The remainder of the retained concepts considered by the Group are noted for the record in Appendix C. No specific recommendation

for action on these concepts was made because the apparent advantages to be gained were not now thought to be compelling, and it was felt that any definitive action might be premature.

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SECTION II - DISCUSSION OF SELECTED ADVANCED MATERIEL CONCEPTS FOR URBAN WARFARE

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SECTION II - DISCUSSION OF SELECTED ADVANCED MATERIEL CONCEPTS FOR URBAN WARFARE

II.1. Small, Controllable Airmobility Device (WASP - WAndering SPy).

Problem:

A major advantage of the defender in urban conflict is that the attacker must approach defended positions by known routes while the defender remains concealed and difficult to identify or locate by conventional means.

Background Discussion:

At the present time, almost the only way of making a systematic search of an enemy-held urban area is to accept the losses which normally occur when detachments of men physically search out enemies in concealed positions. It is extraordinarily difficult to clear a building, since each room is a potential ambush which must be approached with great caution. In many cases, the presence of an enemy can be detected only by jeopardizing or sacrificing the first member of a search party to enter a room. Clearing out each room by grenades or similar devices prior to entry is by no means reliable, although it is the Army's current procedure; even a simple corner barricade made of furniture or mattresses is often sufficient to provide the defender with effective protection against a grenade. In view of this, it is clear that the advantages held by the defender would be reduced by some device or procedure which would make it possible for the attacker to investigate potential defensive positions while himself remaining in defilade.

Concept:

One such device can be visualized as a small ($\approx$12") controllable flying machine carrying appropriate sensing devices as its payload. It is proposed that the WASP be equipped with either a video camera or some other type of imaging device so that the operator can see the areas of interest. Ancillary sensors might also be used to aid in the search of darkened rooms and corners or where the enemy has made use of cover or camouflage. The device should have free-flight capability, but under complete control of the operator. The operator would see, on a video screen, a projection of the area being scanned by the device's sensor.

The flight range need not exceed about 200 m, since its greatest value would be in the ability to reconnoiter rooms, tunnels, and so on, at relatively short ranges. Flight durations of 20 minutes probably would be sufficient.

The problem of control might be solved by having the device tow a control filament which may also provide a video channel for the sensor. The device should be small and capable of negotiating small openings such as windows and doors. The speed need not be great; but it should be extremely agile, capable of hovering, and flying in any direction. A device based on the ducted fan principle might be practical.

Tactical Employment:

The WASP is launched from a protected spot and flown to the building to be examined. Under control, paying out its control and communication (and perhaps power) line as it goes, the device is flown into all available openings and the interiors are systematically scanned.

II.2. Observation Obstruction Foams.

Problem:

A significant problem for the attacker in urban conflict is that the defender has presumably selected observation points and weapons positions covering all possible avenues of approach. These positions will be concealed, and it can be assumed that there will be a number of alternate positions commanding the approach areas. The problem facing the attacker is to locate the occupied positions, suppress observation and fire, and move across and into the zone covered by enemy weapons.

Concept:

It is proposed that quick-setting foam plastic curtains would provide a partial solution to the problem. The curtain should be deliverable by conventional artillery weapons, mortars, rockets, or flame throwing equipment. The spigot principle, used with conventional gun tubes, might deliver adequate volumes of material.

The setting time should be as short as possible. A setting time, from projectile impact to the formation of a firm material, of about one minute would probably be acceptable, and 15 seconds may be feasible in the opinion of consultants. The foam should have the maximum final volume/original volume ratio that is commensurate with the properties desired. The material should be tough, to resist cutting to some extent, and opaque. It should stick firmly to stone, metal, brick, and glass so that it could be placed against a large vertical surface and produce an integral curtain over all small openings.

Existing state of the art suggests that a suitable material would weigh about 1.7 Kg per 1000 cc (100 lbs/ft^3) in the original (i.e., unfoamed) state, and that the original volume to foamed

volume ratio would be about 1:200. Achieving rapid setting times will require research; the necessary intimate mixture of resin and polymerizing agent might be achieved by microencapsulation of the polymerizer with the capsules designed to burst upon release of pressure. A wide variety of foams appears feasible ranging from brittle to tough, non-flammable or flammable and of varying opacity.

Tactical Employment:

The tactical employment is envisioned as follows: Defensive automatic and anti-tank weapons fire is coming from concealed positions in piles of rubble, and covering (sniper and automatic weapons) fire is coming from several windows in a still-standing building. The foaming agent is delivered by a self-propelled 105mm howitzer from a relatively protected position. The foam may be contained in a spigot-type munition which is designed to be launched from the 105mm gun tube. The projectiles are launched to impact on the face of the rubble piles and over the top of the building housing the snipers. The foam on the rubble covers the pile and obscures the gun ports with an opaque tough curtain several inches thick. The defensive guns can, of course, fire through the curtain, but observation is lost and the accuracy of the defending weapons thereby seriously degraded. The foam placed against the vertical wall flows down the wall and forms an opaque curtain masking the front of the building. Again the vision of the defender is completely obscured. If the enemy breaks an opening through the curtain to obtain vision, the break in the curtain is immediately detectable so that the attacker can place counterfire on that spot.

Other tactical applications, using foams of somewhat different properties, can also be envisioned. For example, assume a foam which is dimensionally stable but in which a man will sink for 30 cm or so. Such a foam might be used to inhibit the freedom of movement of the defenders, thus degrading one of his primary advantages. Foams of this form could be placed in hallways, stairwells, narrow streets and passages, and subways and sewer tunnels which are used by the defender for micromobility among his several alternate positions. Encounter with the emplaced barriers would not stop such movement, but it probably would inhibit them significantly and thus degrade one advantage of the defending force; some disadvantage to the attacker, however, may also accrue.

Current methods of delivering foaming agents (for example, by carrying tanks of the ingredients on a vehicle, mixing the agents and projecting the mixture under pressure through a hose and nozzle) may be redesigned for the environment of urban warfare. Current devices are large, unwieldy, and vulnerable to enemy counterfire, but such delivery means might be combat-practical with a microencapsulation scheme.

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II.3. Area Denying Foam.

The relative compactness of ordered, man-made structures makes it possible for the enemy to reoccupy formerly cleared positions or occupy sites previously investigated and found to be unoccupied. The danger of such enemy action is especially prevalent under reduced visibility conditions.

Background:

The re-occupation or occupation of buildings or even narrow streets and alleys by the enemy could be made very difficult if one could significantly reduce visibility from buildings to be occupied and/or make them uninhabitable by changing ambient air conditions such as the depletion of oxygen or the introduction of a toxic atmosphere.

Concept:

A persistent but non-hardening foam is generated and dispersed into the spaces to be rendered useless for enemy occupation. Using perhaps local water to which a small percentage of foam-generating chemicals is added, a foam generator similar to a firefighting machine disperses the foam to locations to be "sealed" off. To disperse the foam, the foam-generating mixture is expanded by air, CO_2, freon, or a toxic gas or vapor. The expected expansion ratio is 1:1000 to 1:2000, and a foam can linger for 1-2 days, if no significant air movement is present. However, it can be washed away with a water spray to which, if necessary, neutralizing or congealing agents have been added. Besides the psychological effects (anxiety, etc.) of being engulfed by foam, the individual loses some orientation (whiteout), and if the foam is not dispersed by air but by CO_2, freon, etc., suffocation can be expected. Depending upon the nature of the dispersal gas, the foam can be harmless to humans and would only interfere with observation (on both sides), to allow attacking forces to close in and destroy the enemy with less danger. The foam might also be filled with an air-fuel mixture, thereby providing a means of inserting triggerable explosives into spaces which otherwise could not easily be reached.

In addition to conventional firefighting-type foam generators, foaming material and gas (vapor) shells, grenades, rockets, air-dropped bombs can be utilized, as well as small generators similar to a man-portable flame thrower.

Tactical Employment.

The foam might be applied to fill a room, an entire building, a trench, a street, or even a substantial portion of an urban area.

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In addition to conventional firefighting-type foam generators, foaming material and gas (vapor) shells, grenades, rockets, air-dropped bombs can be utilized, as well as small generators similar to a man-portable flame thrower.

Tactical Employment:

The foam might be applied to fill a room, an entire building, a trench, a street, or even a substantial portion of an urban area.

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II.4. Conceptual Aerial Assault Vehicle for Urban Warfare.

Problem:

To determine what type of aerial assault vehicle would best facilitate establishing a foothold or gaining entry into a defended urban area.

Background/Discussion:

Empirical studies of urban conflicts show that the attacking elements are extremely vulnerable during attempts to gain a foothold or entry into a defended urban area. Assault vehicles used are usually relegated to the surface, i.e., land or water. This surface restriction has permitted the defender to concentrate his defenses to a relatively few avenues of approach that are available to the attacker--enabling the defender to mass his direct and supporting fires to those critical areas--to set up a barrier system, e.g., minefields and barbed wire entanglements--that result in a highly integrated defensive system which has heretofore cost the attacker considerably in time, men, and materiel.

Concept:

An inexpensive, low noise level, simple to operate, and accurate aerial vehicle for delivery of assault forces over short distances to footholds of or entry into urban areas. Additional thoughts on this concept are presented in Appendix B.

Aerial vehicles considered included, but were not limited to:

Gliders.

Ballistic capsules.

Individual helicopter/jet belt.

Auto-gyro devices.

A real advantage accruing to an aerial assault type vehicle would be its ability to negate the present liability of severe limitation on avenues of approach. Aerial vehicles would permit a much greater number of approaches to the outskirts of the urban area, and would allow also the by-passing of the outer perimeter and immediate entry into the inner recesses of the urban area and its key installations such as public utilities, communication centers, etc. Additionally, this type of conveyance would nullify the effectiveness of a passive barrier system that presently blocks, slows down, or channels surface assault vehicles. This capability of aerial vehicles to gain a quick access/foothold at any

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place along or inside the perimeter, would degrade the defender's ability to concentrate his defensive forces and mass his fire. Other advantages of an aerial vehicle (that meet the criteria as established in this concept) are relatively low cost in relation to the cost of a conventional helicopter; reduced vulnerability because of minimal exposure time; and a reduction in detectability because of low signature and low noise level. New defensive tactics envisioned to counter an aerial vehicle assault might be for the defender to distribute more equitably his forces throughout the urban area or to defend lightly the outer perimeter, and hold the major portion of his forces in a reserve; in either case allowing the attacker a much better opportunity to gain access/foothold more quickly and with fewer casualties and less materiel expenditure.

The vehicle systems mentioned above have potential as assault vehicles, either singly or in combinations. Rocket propelled ballistic capsules decelerated by retro-rockets, towed gliders, decelerated/controlled by parachute for normal and/or vertical landing, with a cushioning system such as used for heavy drop loads, are two types of conveyances that might be used.

A limiting factor of this type of conveyance system would be the need for special skills not normally found in the regular Army units. A possible solution would be to give this type of mission to special forces/airborne units who could be highly trained in this type of operation and be "farmed out" to regular Army units as required.

II.5. Remote Control Expendable Ground Reconnaissance Vehicle (TURTLE).

Problem:

The use of armored vehicles ahead of combat infantrymen in urban areas is virtually denied by the threat of anti-tank guns, recoilless rifles, and weapons of the TOW type.

Background:

Sniper fire represents a major threat to the infantryman in urban areas. It would be desirable to provide some measure of armor for the infantryman to avoid this threat. However, there appears to be no upper limit to the amount of armor that is required, since relatively small shaped charged warheads are quite capable of penetrating the thickest armor on the hulls of tanks. On the other hand, the number of such weapons that can threaten a tank in a given combat area is limited.

Concept:

In view of the above considerations, it is suggested that a semi-expendable vehicle could be developed to scout ahead of the approaching infantry and heavy armor, and to be invulnerable to light and medium weight projectiles although incapable of withstanding direct

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hits by armor-piercing rounds. This concept would be adjunctive and/or supplementary to WASP, discussed in paragraph II.1 above.

In view of current technology, it seems unnecessary to have such a vehicle manned. Under current development by the Army are several means of remotely manipulating and guiding vehicles. Thus, if such a vehicle as described were to be developed, it could be quite small and thereby achieve a relatively high degree of invulnerability to enemy fire. It need not be particularly fast, but should have good mobility over rubble strewn streets and be reasonably agile. To maintain small size, the vehicle might not be armed but would serve to locate enemy positions by either drawing fire or through the use of television and other sensors to survey the area of possible enemy emplacements from close range. Upon finding an enemy position, the device would be used to call for and aid in the guidance of direct and indirect fire support.

Tactical Employment:

The device would be employed primarily in urban areas to scout ahead of approaching infantrymen. It might be used at times to pass down side streets as well as ahead of the attacking forces to protect heavy armor from ambush. The principal advantage of the device, other than being unmanned and relatively difficult to destroy by virtue of its small size and medium weight of armor, would be its ability to observe possible enemy positions from very close range. Thus, problems of target acquisition would be minimized and use at short ranges would be possible because the vehicle would be semi-expendable.

SECTION III - CONCLUSION AND RECOMMENDATIONS

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SECTION III - CONCLUSION AND RECOMMENDATIONS

The output of this Ad Hoc Group can not be considered an exhaustive study of urban conflict nor of all the materiel and doctrine appropriate to military operations in urban areas. Therefore, the recommendations of the group take the form of a set of potentially good ideas which appear within the reach of present and near-future technology. No claim is made that these are the only good ideas or the best ideas. The more-provocative five ideas are transcribed below from Section II. The remaining ideas are relegated to Appendix C and are, for the most part, non-positive findings as opposed to negative findings. It is likely that some of the concepts in Appendix C, when more properly described or novelly implemented, might be very attractive.

III.1. Conclusion:

It is concluded that primarily the ideas discussed in Section II, and secondarily the ideas listed in Appendix C, are suitable candidates for possible influence of concept formulation or for variation of emphasis in future advanced development programs related to warfare in an urban environment.

III.2. Recommendations:

The following recommendations are keyed to the corresponding paragraph numbers in Section II.

II.1. Small Controllable Air Mobility Device (WASP).

It is recommended that AMC initiate a feasibility study and, if justified, undertake the preliminary design of this or similar type reconnaissance device, to be followed by advanced development.

II.2. Observation Obstruction Foams.

It is recommended that AMC broaden its existing investigation of these type foams and that CDC be advised to consider the formulation of an appropriate statement of requirement for such a foam and its ancillary delivery equipment.

II.3. Area Denying Foams.

It is recommended that AMC conduct tests at urban mock-up sites to quantify the efficacy of cited foams.

II.4. Aerial Assault Vehicle for Urban Warfare.

It is recommended that AMC initiate a feasibility study of a specialized assault vehicle for urban warfare which would include

criteria of low cost, low noise level, simplicity and high survivability indices.

II.5. Remote Control Expendable Ground Reconnaissance Vehicle (TURTLE).

It is recommended that AMC conduct a feasibility study of this type vehicle, and that CDC determine the relative utility of such a device measured by its expected performance and cost, with a requirement statement promulgated, if appropriate.

APPENDIX A

A1 Letter of Invitation

A2 Strawman Report

A3 List of Participants

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APPENDIX A1

DEPARTMENT OF THE ARMY

U. S. ARMY ADVANCED MATERIEL CONCEPTS AGENCY
WASHINGTON, D. C. 20315

AMXAM   15 March 1968

SUBJECT: Working Group on Advanced Materiels Concepts

TO: SEE DISTRIBUTION

1. Reference AMC General Order No. 73, dated 29 September 1967, establishing the US Army Advanced Materiel Concepts Agency (AMCA), a Class II activity of HQ, AMC reporting to CG, USAMC through the Director of Development, AMC. At a future date, AMCA will be collocated with the ACSI Threat Forecast Group and the CDC Institute of Land Combat.

2. It is planned that AMCA will make frequent use of ad hoc working groups composed of individual technical experts from within AMC and from elsewhere. The first exercise is being planned for the period 25 March through 15 April 1968. Members of the working group should be available full time during that period. It is not expected that there will be any follow-on work by the members of the group after 15 April 1968. Further, members of the working group will be required to meet at AMCA offices, 3220 Duke Street, Alexandria, Virginia, at least on 25 through 28 March and on 8 through 12 April 1968.

3. It is requested that you nominate one member and one alternate to serve on the first AMCA ad hoc working group and approve TDY for the period stated above. Your selection should be guided by the intent of this first study as described in the following paragraphs.

4. The methods of operation of AMCA are not established and initial activities are being undertaken not only for their own sake, but largely to learn how AMCA should operate. The first study group is being convened to examine a methodology for AMCA operation which consists of the following steps:

a. Selection of a field army problem by AMCA. Initial study of problem leading to a useful problem statement, the basis for formulating an ad hoc study group, and a prose description of the problem and desired study that will communicate to the working group the task they are to perform.

b. Study of the problem by the ad hoc working group leading to specific recommendations to the Army on today's actions which will benefit the Army of the future.

c. Documentation, coordination and advocacy of working group recommendations by the staff of AMCA.

5. In accordance with the method outlined in paragraph 4, the first study group is being convened to study systems for clearing a town of enemy forces. The inclosed report has been prepared to communicate to the working group the problem they are being asked to address; it is not a draft solution to be sharpened and edited by the group.

6. The first group is being selected primarily from within the Army, so that senior members of AMC RDTE activities can come together to help AMCA find a meaningful rationale for advanced concepts planning. In this vein, it is hoped that the nominees will be selected for the highest policy making level appropriate to RDTE planning in your organization.

FOR THE DIRECTOR:

PETER D. LENN
Deputy Chief
Exploratory Evaluation Division
(Phone: 202 974-7046)

1 Incl
Strawman Rpt on Conceptual Study of Army Sys for Killing Enemy Troops Deployed Defensively in an Unoccupied Town

DISTRIBUTION:
Technical Director, R&E Directorate, USAMICOM
Technical Director, USA Ballistic Research Labs
Technical Director, Human Engineering Labs
Chief, Scientist, USAMUCOM (2 nominees)
CO, WES, ATTN: Warren Grabau
Director, Combat Surveillance-Target Acquisition and Night Vision, USAECOM
Technical Director, MERDC, USAMECOM
CO, Institute of Land Combat, USACDC (2 nominees)

APPENDIX A2

STRAWMAN REPORT ON A CONCEPTUAL STUDY

OF ARMY SYSTEMS FOR

KILLING ENEMY TROOPS DEPLOYED DEFENSIVELY

IN AN UNOCCUPIED TOWN

NOTE: The statements in this appendix were written in a predictive mood, as a thinking guide for the first ad hoc study group, and circulated before the group met. It is included here for completeness and historical interest only.

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I. Statement of Problem.

A study was undertaken directed toward the formulation, evaluation, selection, and recommendation of plausible systems for achieving the following specific field army objective:

Kill enemy troops deployed defensively in an unoccupied town.

This problem statement was amplified during the course of the study in the following ways:

a. Systems leading to capture or incapacitation may be viewed as intermediate steps to killing and, in fact, very difficult steps to achieve. Thus, it was assumed that our deliberations would not be limited by thinking of killing as the final required step.

b. Defensive posture of the enemy troops was taken to mean that the enemy would not advance or attack except locally as a tactical step in defending his static position.

c. It was assumed that there is generally some positive value to achieving the goal swiftly, with little loss of friendly forces, with little destruction of the town, and with little cost.

d. It was assumed that concepts involving other than Chemical Biological and Nuclear (CBR) munitions would be of greatest utility.

e. It was assumed that there is an advantage to systems which could also be used in a town occupied by a non-participating civilian population whose safety is of some interest. However, the problem of the unoccupied town seemed broader and therefore more applicable for this study.

II. Method of Attack.

Among the thought patterns pursued in the study were:

a. What distinguishes a town from non-town environments?

b. What causes an enemy to assume a defensive position in a town rather than either an offensive position or defense in the countryside?

c. What are some of the standard problems in taking a town?

d. What generic ways are there for killing people in a town?

No deductive series of statements led directly from one or more of these questions to the concepts for systems developed by the committee.

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However, the consideration of questions like these did seem to guide the thinking of the group. Therefore, some aspects of the discussion of kill mechanisms will be presented in an attempt to document the group dynamics in the hope of providing later groups with the benefit of our experiences.

III. Paraphrased Dialog on Kill Mechanisms.

In attacking the problem of killing enemy troops, a discussion of means of producing death occurred. One classification suggested was as follows:

Direct Physical Action on the Soldier.

a. Mechanical Forces.

Blast		concussion
Bullets	causing	hemorrhage
Shrapnel		dismemberment

b. Mechanical introduction of poisons, irritants, and toxic agents.

c. Nuclear radiation.

d. Electro-Magnetic radiation.

Action on the Environment.

a. Temperature, pressure, chemical composition, foreign matter in the "air."

b. Gravity.

c. Motion of the ground.

d. Light.

e. Sound.

f. Appearance of the surroundings.

In other words, the ways to kill a person involve either breaking the machinery by direct action or altering the environment such that the human machinery cannot survive. In discussing this classification (which is suggested as neither complete nor precise), two categories were ruled out as related to CBR warfare:

a. Poisons, irritants, and toxic agents.

b. Nuclear radiation.

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Several more were rejected on intuitive grounds as infeasible and/or impractical:

a. Electro-magnetic radiation.

b. Temperature, pressure, chemical composition of "air."

c. Gravity.

d. Light.

e. Appearance of the surroundings.

f. Motion of the ground.

Thus the discussion was narrowed to:

a. Mechanical forces.

b. Sound.

c. Foreign matter in the air.

From here to the conception of the systems suggested in the next section of this report, a transcript of the discussion would only be the footprints left by minds in the process of thinking their way from here to there. The footprints tell little of the story and will not be reproduced here. Let it merely be recorded that upon reflection, the group felt that the discussion just recounted had a salutory effect in getting them started on a profitable train of thought.

IV. Systems Concepts.

From their deliberations, the working group conjured up a number of systems concepts. These were debated, analysed, and compared. Finally, it was decided that two concepts seemed to be sufficiently promising and practical to be advocated for exploratory development efforts by the Army. In advocating these systems concepts, the working group is not claiming to have exhausted the possible solutions to the original problem, nor to have selected the "best" solutions. The appropriate statement is rather that, having studied the problem, the group has found these two avenues to pursue for achieving a more capable Army.

System Concept A.

This system consists of a usual aggressor force augmented with equipment that will make noises affecting the ability of the defenders to sleep. By disturbing the sleep of the defenders for 24 to 36 hours, and then making sleep inducing sounds, a large fraction of the dispersed defender force will be sleeping at a specific time and can then be searched out and killed in the usual ways with less hazard and cost to the aggressors. The aggressor will also have armored vehicles for deploying the sound sub-systems throughout the town and will emplace troops to guard them. If the defenders take aggressive action toward the sound sub-systems, the advantage

of protection afforded by buildings, etc., will transfer to the guard patrols of the aggressor. The power and equipment costs were evaluated and found to be within practical bounds as an aid to taking towns. The analyses supporting this contention are described in Appendix A. To substantiate the feasibility of this conceptual system requires exploratory development along the following lines:

a. Interference with sleep through the use of sound.

b. Countermeasures to sleep interference.

c. Inducing sleep in weary troops.

d. Countermeasures to sleep induction.

Once more definitive information on sound-sleep interactions is in hand, the remainder of the system can be designed and evaluated by conventional military and engineering methodologies.

System Concept B.

This system consists of a usual aggressor force augmented with two distinct subsystems:

a. A group of fossil-fuel powered machines for processing and dispersing dust from local soils and rocks, so as to produce conditions of near-zero visibility.

b. A group of devices for seeing through the clouds of dust by far-infrared imaging and pulsed lighting-gated viewing techniques.

This system would firstly destroy the protective cover advantage of the defender and secondly offer an advantage to forces equipped with the dust-penetrating vision devices. The calculations presented in Appendix B indicate that all technical building blocks for this system are in hand; that the system will work well for towns of any size in winds up to 20 knots continuous or gusts of 25 knots; that the vision devices provide target acquisition and IFF capability at 100 feet (approximately 10 times the unaided visual range in the dust storm); that the cost of producing the dust storm is comparable to the usual cost for artillery and mortar fire support of an attack on a town; and that the cost of the vision devices is comparable to the usual cost for artillery and mortar fire support of an attack on a town; and that the cost of the vision devices is compatible with usual guidelines for equipping individual soldiers. It was also decided that simple precautions like use of cloth face masks dampened with water would allow an indigenous population to survive the dust storm; and also allow the population to evacuate during the battle with little risk of being hurt.

In the opinion of the working group, there are no technical obstacles to the development of this system and that the design parameters

presented in the appendix are sufficiently accurate to be used for a final decision on the cost/effectiveness of this sytem. It is therefore recommended that the appropriate element of the Army undertake an evaluation of whether this feasible system should be part of the Army's materiel/techniques inventory.

APPENDIX A3

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APPENDIX B

ANALYTICAL APPROACHES USED IN THE STUDY OF FUTURE ARMED URBAN WARFARE

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APPENDIX B - ANALYTICAL APPROACHES USED IN THE STUDY OF FUTURE ARMED URBAN WARFARE

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B.1. Special Environmental Characteristics of Urban Conflict.

The objective of this appendix is to identify advanced materiel concepts that could be used to advantage in warfare within the environments of urban areas. The approach is based on the notion that an examination of the urban environment will lead to the identification of devices or procedures which would be particularly effective in that context.

B.1.1. Description of Method.

An urban environment is quite different from that of the non-urban countryside, and, because military operations are strongly affected by environmental context, it may be expected that an examination of the special urban environment might lead to concepts of value to either the attacker, defender, or both.

B.1.2. Sample Descriptions of the Environment.

Since this examination is founded upon the recognition of special environmental conditions, it follows that the ways in which urban environments differ from the more widely understood environment of the countryside must be identified. Unfortunately, urban environments differ among themselves as much as do non-urban environments. Urban areas vary as a function of the cultural pattern of the people who built them, the availability of construction materials, the age of the urban area, the topographic setting, the climate, the size of the population accommodated, etc. A few "type examples" may be cited to illustrate the variability.

a. The stone cities and towns of southern Italy, in which nearly every wall is made of stone, are one example. Even ceilings and roofs are sometimes of stone, carried on barrel vaults and similar supports. Combustible material is at a minimum; roof beams, sheathing, and furnishings are the major components. Streets are narrow, crooked, and tend to be paved with stone blocks, which can easily be removed and placed to form barricades. Such cities are comparatively more resistant to non-nuclear explosives.

b. The brick cities and towns of the Low Countries, in which most exterior and many interior walls are made of brick, have somewhat similar characteristics to the southern Italian towns and villages. Streets are mostly narrow, but usually straight, and deep canals taking the place of streets are common. Almost all ceilings and roofs are composed of wood, as are many interior walls and floors, so that combustible material is much more common than in the first example. Streets are often paved with brick, easily removed and formed into barricades. Such cities are easily reduced to rubble by explosives, but the resulting piles of debris offer countless tunnels, cavern-like openings, and other places of concealment. Once the city is reduced to rubble, explosive munitions only rearrange the surface, and the rubble tends to be as defendable as the original city.

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c. The steel-and-concrete "new" cities all over the world provide a completely different environment from the above. A "new" city is one built largely within the last 50 years. Examples include Tokyo, Bangkok, Manila, Saigon, Melbourne, Chicago and Rio de Janiero. Many smaller cities or areas within cities have the same features. These urban areas are characterized by wide, straight streets arranged largely in a grid, paved with large slabs of concrete or with continuous sheets of asphalt cement. Steel-framed buildings are easily penetrated by projectiles, and the facing bricks, stone, metal, or other materials are easily stripped off by explosives. The frame may stand, but the rest of the structure accumulates in piles of debris about the base, and debris and rubble are useful to the defender, as previously noted. Buildings of reinforced concrete are similar (the frames are very resistant) with the added factor that the floors, which are also usually reinforced concrete, are resistant to penetration. Only the furnishings and a few roof sheathings are combustible.

d. Wooden cities, in which the entire building is made predominantly of wood, provide poor defensive positions. It should be noted that urban areas of this type are very common; with the exception of their commercial centers and industrial areas, nearly all of the "new" cities are of this type. Many large towns in the colder portions of the northern hemisphere (Canada, Alaska, Scandinavia, the Soviet Union) are of this type. Streets tend to be wide, straight, arranged on a grid pattern, and paved with Portland or asphalt cement. Such cities are extremely combustible; almost all of the buildings and their furnishings will burn. Once burned, very little remains to provide cover or concealment. Towns of wooden frame, thatch, and mat construction, including most towns of Southeast Asia and Indonesia are variations of this type.

e. The adobe cities, common in dry climates around the world (the Near East, Iran, parts of Afghanistan, India, and Pakistan, North Africa, Mexico, and much of Central America, and parts of the United States) are of intermediate utility in providing defendable positions. Most walls, both interior and exterior, are of mud brick or rammed earth, with roof beams and sheathing of wood. Such construction is reduced to mounds of clay rubble very readily by explosives, but the resultant debris has many of the characteristics of burned brick (see type b). Streets tend to be relatively wide, and may be paved with stone, Portland cement, asphalt cement, or simply packed earth.

It should be noted that probably no large city is entirely one of the types described briefly above. Rather, there is usually a dominance of one type with greater or lesser admixtures of one or more of the other types. Thus, rigid categorization is difficult, and would usually be seriously misleading.

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B.1.3. General Conclusions About the Urban Environment.

Despite the complexities of type, the environments of urban areas do present certain characteristics which have great military significance. These, in general, are as follows:

a. The planimetry of the terrain is regular and arranged along straight, interconnecting lines. This condition is rarely, if ever, found in the countryside. Even after the buildings along the streets have been reduced to rubble, the surface is still ordered in accordance with the basic street pattern. One major military product of this condition is that the defender can organize fields of fire which will be effective even when vision is partially blocked by smoke or dust. Weapons, especially artillery and antitank devices, can be pre-aimed to sweep the only possible avenues of approach which can be used by vehicles, and antipersonnel weapons can be assigned fields of fire with appropriate overlap and fire density to protect the artillery and antitank weapons.

b. The terrain is three-dimensional in a very special sense. Covered and concealed places from which weapons can be operated exist at many levels, a situation almost opposite to that in the countryside where suitable positions are usually at ground level. This means that searches to acquire targets are much more complex, if for no other reason than that the zone of search must extend vertically as well as horizontally.

c. The urban terrain is nonhomogeneous. It contains innumerable "caves" and "tunnels", typically both covered and concealed. The "caves" are all potential sites for weapons and the "tunnels" (including sewers, utility tunnels, subways, hallways, etc.) offer protected and concealed avenues for communications, the shifting of men and supplies, and so on. Ordinarily there are many more potentially usable weapons and/or personnel sites than there are men to man them. Thus, a defender has the option of moving his weapons among a number of pre-selected sites along covered and concealed routes, thus adding materially to the attacker's problems in acquiring targets and planning assaults.

d. The urban terrain consists largely of man-made materials; brick, stone, metals, wood, glass, etc. Thus, there are no "non-natural" elements in the terrain to provide a clue as to the location of occupied positions. In the countryside, the search techniques involve, among other things, the location of disturbed areas, and of objects with too regular or otherwise unnatural shapes; in cities, everything is disturbed and all shapes are "natural" to the terrain. The effect of this property of the terrain is to make concealment very easy and detection very difficult. Any crevice in a pile of rubble and any tile fallen from a roof may conceal a

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weapon. Since such openings exist by the thousands, especially in cities in which the buildings have been partially destroyed, the task of target acquisition is extremely difficult.

e. The materials composing the terrain of urban areas are heterogeneous. In the countryside, the materials tend to be relatively uniform over large areas; soil types change from place to place, but the changes tend to occur over relatively large distances, and they tend to be organized into easily-recognized patterns; vegetation changes are abrupt, in many instances, but they are on an easily-recognized scale. Not so in cities: materials change radically within distances of centimeters, and small blocks or masses of bricks, asphalt, metals, glass, stone, wood, etc., occur in jumbled masses. An important effect of this property is to make target acquisition very difficult, especially for sensors using the electromagnetic spectrum, since the background clutter is extreme. A broken piece of armor plate will look very much like a piece of sheet-metal roofing, and so on. The property of heterogeneity also makes concealment from visual observation easy; any haphazard arrangement of bricks and broken rock, piled to conceal an artillery emplacement will look like any other pile of rubble.

f. The urban terrain is resistant to explosives, espeically after the buildings are partially destroyed and the lower floors are banked with rubble. More explosives applied to such an area tend to rearrange the surface and break up the surface pieces into smaller pieces, without affecting the interiors of the piles or the buildings in any significant way. (Earthworks in the countryside also have this property but to a lesser extend because the material is less resistant).

g. The urban terrain is characterized by abnormally short free-path distances, although trajectories along streets, or over rubble piles may be as long as in the countryside. Inside buildings and among rubble piles of effective ranges are measured in meters rather than tens or hundreds of meters. Each room or hallway is an effective terrain compartment. One result is that firing ranges are short with a concomitant reduction of required response times to very short intervals. Since a competent defender knows the potential avenues of approach, he is provided with a great advantage. The small compartmentation with the resulting short firing ranges also makes it difficult, if not entirely impractical, to use heavy weapons for the process of eliminating detachments of personnel inside buildings; the heavy area-effective weapons are likely to be as lethal to friend as to for.

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B.2. Analysis of the Characteristics and Vulnerabilities of the Opposing Forces in Urban Conflict.

One analytical methodology used by the study group involved examination of: (a) the characteristics and activities of the opposing forces in an urban conflict environment; (b) the functional systems which each of these forces require to perform their missions; and (c) the vulnerabilities of the systems and their components to possible action of the opposing force. Consideration was given to means by which specific capabilities of the attackers might be enhanced and/or the corresponding capabilities of the defenders degraded in order to gain advantages for the attackers. The analysis culminated in the identification of some specific problems facing the attackers and generation of operational or materiel concepts which, it is hoped, might alleviate the problems.

B.2.1. Basic Characteristics of Military Forces.

The following are basic characteristics or functional objectives of military forces (both the attack and the defense) which might be modified in some way (to the advantage of the attackers or the detriment of the defenders) to achieve the stated military objective(s), or at least to improve the current military capabilities to achieve the objective:

Firepower:

Including weapons, ready stocks of ammunition, fire control, and physical protection.

Mobility:

Including both vehicular and personal mobility.

Command, Control and Communications:

Intelligence:

Intelligence concerning opposing forces, including direct observation.

Counterintelligence, including concealment from opposing forces.

Combat Support Services and Materiel:

Food, water, ammunition, medical services, etc.

B.2.2. Basic Capabilities of Personnel and Materiel.

Both men and materiel usually are required to implement or utilize these basic functional objectives. In most cases material components are used to enhance the combatant's basic capabilities, increase protection or concealment for him, or increase his firepower capability. It is felt that postulation and subsequent evaluation of concepts for enhancing the operational functions can be made more systematic by using such basic capabilities. The following table presents a general characterization of these elements. An attempt was made to draw analogous definitions between human and materiel capabilities whenever possible.

BASIC CAPABILITIES

Personnel	Materiel
I. SENSES-(Sight, hearing, and possibly smell and touch)	I. SENSORS-(IR, EM, sound, etc.)
Primary characteristics used for target identification, target acquisition, observation, and intrusion detection.	The capability of materiel which will increase or extend man's capability to identify and locate targets, observe enemy movement, improve weapon accuracy, and tetect intruders.
II. MACRO-MOBILITY-(Run, walk, swim, crawl, jump, etc.)	II. MOBILITY
Primary characteristics which determine man's ability to move forward or laterally with speed and agility.	The capability of materiel items to enhance directional capability, speed, agility, and control of personnel.
III. RATIONAL THINKING	III. DATA PROCESSING AND RETRIEVAL
This characteristic allows man to absorb and process sensory and other data, make quick predictions, reach timely decisions, and initiate actions.	The capability of materiel to absorb and process sensory data, choose between predetermined alternatives, and initiate response or provide practical data on a timely basis for a human operator to reach decisions. These usually extend man's capacity or the speed at which man can make final decisions.

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Personnel	Materiel
IV. COMMUNICATION -(Voice, body movement, touch, etc.) This characteristic is essential for nearly all of the functional objectives.	IV. COMMUNICATION The capability of materiel components which increase man's capability by decreasing threshold levels and increasing range, efficiency, and modes of communication available.
V. MICRO-MOBILITY-(Motor functions of the body) The capability, ranging from normal to some acceptable lower limit, required to perform mission tasks such as aiming and firing weapons and using target acquisition, fire control, mobility, or communication equipment.	V. OPERATIONAL CAPABILITY The capacity for materiel components can be determined to some degree by determination of range, duration of operation, reliability, environmental requirements, signature, vulnerability, and maintainability.
	VI. COVER AND CONCEALMENT The capability of materiel to provide barriers (physical or otherwise) which will defeat, degrade, or render ineffective basic damage mechanisms and to provide concealment, camouflage, or obscuration so that man is less vulnerable.
	VII. FIREPOWER The capability of materiel to improve and extend man's capability to inflict damage to opposing troops.
	VIII. SUPPORT MATERIALS Material which provides required support in urban area conflict. This will include such items as food, water, POL, ammunition, and medical supplies.

B.3. New Technology and Possible Applications.

One of the most productive means of discovering new concepts is to review and appraise new events, developments, and discoveries in technology. A comprehensive list is virtually impossible to prepare, but a somewhat restricted list can be readily formulated. Relying heavily on judgment, the panel noted the following to be of possible interest and applicability to urban warfare and, to the panel's knowledge, not fully (or in some instances not even partially) incorporated in the Army's planning for the 1975-1990 period. These potentially significant items are:

a. Very-high-power radiation sources.

b. Small and cheap sensors.

c. New materials and material processing techniques.

  (1) Very-high-strength materials (tensile strengths of approximately $4x10^6$ psi).

  (2) High-energy-absorbing materials for armor.

  (3) Aerosols.

  (4) Encapsulation of corrosive, abrasive, and other active chemicals, including CW agents.

  (5) Foams.

d. Signal and data processing.

e. Communication.

f. Prime power generation and conversion.

g. Information/intelligence acquisition, reduction, storage, and retrieval.

h. Night vision devices.

  (1) Low-light-level and infrared.

  (2) Covert and semicovert augmentation of light.

i. Holography.

j. Transportation.

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Conversely, the panel believes there are certain areas of technology in which fundamental innovations are unlikely. Some of these are the heat yield of chemical reactions (implying that more energetic warheads and rocket motors are unlikely), more-efficient aerodynamic surfaces, and higher horsepower-per-pound performance of heat engines. In some instances, significant progress will be made even though the fundamentals are basically the same (e.g., better warheads are possible, using today's explosives, if a means can be found to better convert the potential energy of the explosive to the kinetic energy of the fragments; and improved range-payload characteristics of missile motors are certain to be developed through the use of air augmentation).

B.3.1. Technological Items.

In the following paragraphs, the ten technological items listed above are discussed in greater detail.

B.3.1.1. High Power Radiation Sources.

The Army is currently utilizing the small Q-switched ruby and neodymium laser, operating at 10 to 20 pulses per second and a few tens of millijoules per pulse, in a number of applications. Further improvements of such lasers to obtain high repetition rates and power output through the use of new lasing materials are expected and will not be commented upon in this discussion (nor will there be comment on evolutionary improvements in the state-of-the-art in the discussions of other technologies to follow). However, the advent of the CO_2 laser operating at 10.6 microns with the potential of producing coherent output at power levels of tens of kilowatts and, quite probably, at megawatt levels, is certainly not an evolutionary development in the above sense.

There is a distinct possibility that any attempt to beam such a high power density through the atmosphere will fail because heating of the atmosphere will produce variations of refractive index along the line of sight which destroy the collimation of the beam, or because the atmosphere will be ionized and become highly absorbing. The high power laser beam might be very effective against optical devices, viewfinders, and viewing slits of armored vehicles. One can also conceive that a beam of high power density might be used to destroy guided missiles in flight and to predetonate incoming warheads. However, these speculations remain to be investigated when lasers of the requisite power level become available.

For the specific use of such lasers in urban warfare, we envision the possibility of pumping sufficient power through an open window to make a room uninhabitable and to ignite inflammable materials contained therein. Under some circumstances, one can anticipate the use of a high power laser beam to melt, weld, and fuse materials at reasonable distances. Unless properly shielded, such a beam would, of course, be lethal to men.

While a device with these capabilities is certain to be called a "death ray" by journalists, it is not a panacea weapon for tactical warfare. We have noted the possibility that such a device may be useful only at fairly short ranges due to the atmospheric turbulence induced by the high power densities which would be utilized. Obviously, great care will be needed to protect the instrument itself and its operators from reflected energy. Furthermore, the problem of generating sufficient power to run the machine is not trivial. The panel believes that on-going and projected development efforts in the laser area have important relevance to urban warfare.

B.3.1.2. Small and Cheap Sensors.

From a technological viewpoint, the process of making a sensor smaller and cheaper without sacrificing performance is certainly not a radical innovation. However, evolutionary improvements can, at times, lead to radical changes, and we believe that small and cheap sensors (along with modern signal and data processing) will lead to a degree of battlefield and combat automation that seemed impractical as recently as two or three years ago.

By way of illustrating our point, we note that with sensors now available there is no longer any justification for ordering an infantryman to enter a room which may contain booby traps or enemy soldiers, since a small sensor can be pushed or thrown into the room to do the job of determining whether the room is occupied as well as or better than the soldier can do it. Furthermore, the sensor is not greatly jeopardized by unoccupied but booby-trapped rooms, and, in any event, is an expendable item. For this type of mission, we suggest that an ultrasonic device capable of detecting movement is a good choice. Such devices can be made with sufficient sensitivity to detect the chest movement of a man breathing, or if the man attempts to hold his breath, the involuntary movements common to all animals. By using a sufficiently high frequency, the sound waves will not penetrate the walls of the room, which is a desirable characteristic. The ultrasonic movement sensor will be plagued to some extent by false alarms produced by such things as curtains blown by a breeze or by mice and rats running through unoccupied buildings. The false alarm problem cannot, however, be considered crucial.

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Other applications for the small and cheap sensor are to detect the enemy's moving through perimeters and along roads, and re-entering buildings and areas which have been previously searched and found to be empty. For this application such devices as thin-film magnetometers are rather attractive, since combat troops normally carry a fairly large amount of ferrous metal in rifles and other equipment.

For still other applications, such as maintaining roadblocks and perimeters, the MTI (moving target indication) form of short range radar appears attractive. Applications can be found for infrared devices to locate sources of heat such as the engines of operating or recently operated vehicles. Acoustic and seismic sensors have potential applications in monitoring the movement of men and vehicles. Finally, combinations of such sensors can be utilized to minimize the effects of spoffing and deception on the part of the enemy as well as to reduce the difficulties of interpretation due to the false-alarms that are inherent in sensors.

The final area in which we envision the small and cheap sensor to have utility is in certain forms of weapon guidance. For a fully autonomous weapon-guidance package, the cost of the sensor is often relatively insignificant due to the costs of signal processing, autopilots, control mechanisms, and other subsystems of the complete weapon. However, in certain applications, such as the semiactive laser guidance programs now being sponsored by the Army, the cost of the sensor <u>is</u> significant. Specifically, in the case of the semiactive guided bomb, the illuminator is not expended with the weapon but only a sensor, a simple autopilot, and the actuators for the control surfaces are lost when the weapon detonates. It appears that weapon guidance costs of the same order as the cost of the warhead itself are possible. Since such guidance can easily improve the accuracy of bombs and rockets by a factor of 2 to 10 or more, the cost-effectiveness of such a simple guidance package is highly favorable.

B.3.1.3. New Materials and Material Processing Techniques.

During the last two decades materials of tensile strengths 10 to 20 times greater than that of currently available steel have been developed though, as yet, they are available in only very small pieces and quantities. Basically, such materials consist of single crystals of filamentary nature (whiskers) embedded in a matrix of metal or other compound. Relative to the typical tensile strength of steel of about 200,000 psi (or about 500,000 psi for the newly developed "strong steel"), the theoretical tensile strength of iron is about 1.8 million psi, of boron about 2.5 million psi, of alumina about 3.8 million psi, of silicon carbide and graphite about 5 million psi.* Interestingly, the nonmetals, graphite

*"Fibre-Reinforced Metals", Anthony Kelly, Scientific American, February 1965, p. 28.

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and boron, and the compounds, alumina and silicon carbide, are theoretically much stronger than the metals. In laboratory tests of minute quantitites of perfect and near-perfect single-crystal whiskers of these materials, the maximum theoretical strength of iron has been achieved, and 50 to 60 percent of the theoretical limit has been achieved with alumina, silicon carbide, and graphite. The important and significant practical problems which remain in the development of superstrength materials include both the production of such crystals in great quantity at reasonable cost and the finding of ways in which such crystals can be imbedded into a suitable matrix. However, we feel reasonably confident that such problems will be solved and that such superstrength materials will have utility in urban combat operations.

One fashion in which we speculate that such materials will be of service is in building lightweight catwalks which can be strung over the roofs of a city. According to Army doctrine, the perferred way of entering a building is from the top down. It is at least conceivable that armies of the future will attack a city in accordance with the doctrine if means can be found to get the troops onto the tops of buildings as a routine matter rather than as an occasional event. A further development of this general notion would result in the suspension of landing mats for helicopters and paratroops over the roofs of city buildings.

Some of these materials may be useful as armor. Limited tests have been conducted which are very encouraging but much more work is needed.*

Intuitively, we feel that very strong material should be of great importance to the Army but we have not, as yet, found many convincing illustrative examples of this belief.

B.3.1.4. High Energy Absorbing Materials.

The obvious utility of materials having high energy-absorbing capability for both body and vehicle armor is self-evident. We feel that much more can be done on this problem with the result of providing reasonably good protection to tanks without the massive penalties associated with 12 to 18 inches of armor plate on the hull, and in protecting individual troops exposed to small arms fire, mortar and grenade fragments, and other projectiles of low to medium velocity.

* "Metals with Grown-In Whiskers", M. Salkind and F. Lemkey, International Science and Technology, March 1967, p. 52.

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B.3.1.5. Aerosols, Encapsulation and Foams.

No list of new material processing techniques would be complete without noting the important changes that have evolved from the availability of aerosols for dispersing chemicals, encapsulation for passivating active chemicals and foams for applications ranging from insulation to high strength composite material structures. Applications for and use of these material processing/handling techniques have been noted elsewhere in this report and it is expected that new uses for these techniques will continue to be found.

B.3.1.6. Signal and Data Processing.

The extraordinary rate and degree to which data processing is penetrating commercial, industrial, governmental, and military affairs is well known. We anticipate this trend will continue and be augmented as equipments which are faster, more commodious, and, most importantly, easier to program become available. Today's machines are more often limited by software than by computing speed or memory capacity. We anticipate that this restraint on the use of data processing will be temporary.

The utilization of such machines in logistics and control is rather obvious. We further anticipate important usages will continue to develop in the fields of information and that a modest degree of pattern recognition capability will begin to be available for use by intelligence functions in the 1985 era. Logistic requirements will be processed largely by machine by that time.

The quasi-revolution now occurring in signal processing is not as well recognized. Pattern recognition, as previously noted, is one application for signal processing. Another is the extraction of signals buried in noise and clutter. In general, the mathematical and conceptual foundation for advanced forms of signal processing has been available for many decades but the modern system designer has just begun to organize his systems in such fashion that signal processing is simplified and the results are enhanced. Examples of systems well organized for the use of advanced forms of processing include the Army's SAM D radar development which transmits a variety of modulation waveforms, each of which is partially optimized for the tasks assigned. As combined with the small and cheap sensors described above and proper communication tie-ins, such signal processing, should prove to be of considerable benefit in the urban fighting problem.

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B.3.1.7. Communications.

The most striking development in communications that will become available by 1975 and be available in large quantity by 1985 is the utilization of tactical satellites. Through the use of satellite communications, it will be literally possible to establish a real-time link between any two points in the world with further advantage that such links will be available on an almost instantaneous basis to newly deployed troops. For example, it will be technically possible for an intelligence man located in the United States to talk directly to a front-line trooper in a remote region of the world, whose unit has just arrived on the scene, while the trooper is in the process of entering a strange city. If desired, the trooper could be communicating with a computer to obtain information concerning the disposition of buildings and other information of interest to him as he enters the strange city.

Such communication links will not, however, be routine. Power and bandwidth limitations in satellites will continue to limit the number of available channels and the need for high gain receiving antennas on the ground will generally limit the smallest practical front-line terminal to sizes suitable for installation in jeeps but not sufficiently small to be carried as a part of a man's personal equipment.

Because of the power and bandwidth limitations and the fact that most of the communication traffic that exists in forward areas is local to the area, it is unwise to use satellites for short haul communications. However, when operating in cities where buildings tend to obstruct and interfere with radio communications, a problem exists. We suggest that a very high-flying and very high-endurance drone would be an ideal relay station for short haul traffic between points within the battle area and as a relay station for communicating with satellites. Noting that above the jet stream winds are of the order of hundreds of miles per hour and that the payload of an aircraft designed to fly slowly may be quite large, we suggest the investigation of high lift wings capable of operating at altitudes of the order of 60,000 to 90,000 feet and the development of high altitude power plants of high power-to-weight ratios and capable of maintaining speeds of the order of 80 or 90 knots. An aircraft of this form serving as a communication relay would also have numerous uses in general surveillance, early warning, command and control and other applications if payload is sufficient to permit these ancillary functions.

Other aspects of modern communications that will assist in urban combat will include the use of selective address for personal receivers and effective means of coupling the small sensors previously described to remote data storage and signal processing.

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B.3.1.8. Prime Power Generation and Conversion.

The Army's needs for prime power sources and energy storage devices range from improved small, long-lived batteries to generators capable of delivering tens of kilowatts on a sustained basis.

To operate man-carried radios and other equipment and to power remote sensors, the typical preferred choice of power is chemically operated batteries. Thermionic converters operating from the heat produced by the natural decay of strontium and other radioactive materials have some potential for providing compact, long-lived power sources but, in general, such units will not be used because of shielding requirements and the hazard that results if the integrity of shielding is destroyed in handling or by battle damage.

For medium sized power sources, fuel cells offer significant promise of quiet and reliable operation and we envision that the motor generator sets in current use which deliver a few hundred watts to a few kilowatts will largely be replaced with fuel cell power sources in the next 15 years. It is quite possible that fuel cell applications will extend to even larger power sources, but the likelihood of developing a power source of a few watt-hours' capacity that is more economical than a conventional battery is very slight.

The impact of improved power sources is not in itself directly applicable to combat in cities. However, the indirect effects of making equipment smaller, more portable, and-hopefully-cheaper to produce and easier to operate should permit the utilization of equipment in circumstances and situations which are now impractical.

B.3.1.9. Information/Intelligence Acquisition, Reduction, Storage, and Retrieval.

While we know of no revolutionary advances in information and intelligence acquisition which will permit new sensors to "see" through buildings (with the possible exception of holography, as described later), we believe the cumulative effect of new and improved sensors which perform somewhat better than their predecessors, better means of interpretation, storage and retrieval of information, and the more rapid dissemination of intelligence information will make a cumulative impact of major significance.

B.3.1.10. Night Vision Devices.

We assume that the work being conducted by the Army in developing an extended family of night vision devices based upon passive

sensors operating in the visible and near-visible regions, infrared devices, and sensors utilizing covert and semicovert augmented illumination is known by or available to the reader. There is therefore no purpose in detailed discussion of the means by which this capability will be achieved, but we will note one or two significant guidelines which we have utilized in our examination of the problem.

First of all, it is clear that low-light-level devices cannot equal the performance of the same devices operated at twilight or daytime light levels. In general, resolution and viewing times are inversely related for a given light level and both improve directly with light level. Basically, low light level devices are well suited for use by troops in cities where viewing distances are short and the motions of either targets or the sensor are minimal. The net effect of equipping our combat troops with low-light-level devices will be to develop a 24-hour attack capability. If, however, both the defense and the offense are equivalently and adequately equipped, the defense is favored since the device can be stably mounted to cover lines of access to the defender's position, whereas the attacker must either forego the use of the low light level devices while in motion or accept degraded performance.

B.3.1.11. Holography.

The relatively new technology of holography has an interesting potential application to combat in cities. The basis of holography is to record and preserve a waveform in both amplitude and phase on some suitable storage medium so that a nearly perfect reproduction of the original waveform can be made at a more convenient time and place.

When a visible waveform is preserved in a holographic sense, the reconstituted picture has true three-dimensional characteristics. The observer in viewing the reconstituted image has true stereoptic vision and by moving his head, can obtain true parallax effect. Indeed, with a sufficiently large lateral movement of viewpoint, the viewer can see "around corners" in the reconstituted image to the same degree that he would be able to unmask a line of sight by laterally moving his observation point when viewing the original scene.

Optical holography may have considerable utility and value for reconnaissance and intelligence purposes; but for use in urban combat, one of the more interesting potential applications is with acoustics. The acoustic waveform chosen at a sufficiently low frequency will penetrate solid materials and exhibit the voids within. In concept at least, it will be possible to illuminate a building acoustically with a wavelength of the

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order of a few feet (frequencies of the order of a few hundred cycles per second), holographically record the reflected wavefronts, and reproduce this image in the visible wavelengths. Thus, in a very real sense the observer can "see" the acoustic image of a building, showing him where voids (rooms and hallways) are located, provided such voids are of more the order of a wavelength in size.

The proposed application is highly speculative and fraught with practical problems for realization. The technical risk of not achieving such capability is extremely high, but the payoff probably warrants the acceptance of the costs and efforts required in developing such a device.

B.3.1.12. Transportation.

The importance of good logistics, good troop transport, and battlefield mobility is well known even to casual students of the military art. The importance of supertransports such as the C-5A, improved vertical-takeoff-and-landing machines, novel personnel transport devices such as the so-called "flying belt", as well as improvements in conventional vehicles is self-evident. There is no point in detailed discussion of these developments; but in envisioning the impact of future technology on urban combat, such factors must be recognized and appreciated.

B.4. Operational Aspects of New Technology.

The purpose in reviewing new technology for applicability and relevance to urban warfare is to determine whether the character of in-city fighting is likely to change in a radical fashion and, if so, whether such change would be favorable to U. S. Army operations.

As we have noted, urban warfare is at present an aggregation of many small-unit engagements. The protection and concealment provided by buildings and restriction on movement typical of built-up areas favor small-unit operations. Because communications, command, and control are difficult, such units operate in a decentralized mode and rely heavily on doctrine, and therefore, the coordination of units into massed actions is very difficult. The weapons used tend to be grenades, side arms, rifles and man-portable automatic weapons, recoilless rifles, and missiles. Mortars are effectively used at times but heavy artillery and close air support are much less important than in combat in open terrain. Thus, the key operational problems in urban combat as envisioned by the panel are the following:

a. Entry into a well defended city or town.

b. Accurate, long range weapon delivery.

c. High firing rate, short range weapon delivery.

d. The use of armor (personal and vehicle).

e. Small-unit combat.

The above list is not complete, and important areas such as command and control, communications, mobility, logistics, and other factors are either not included or are only included implicitly. Approached from a different viewpoint, we conclude that the dominant problem in urban combat is to locate with high precision the enemy's troops and weapon emplacements (i.e., target acquisition). Viewed as either a series of key operational problems or as an action dominated in all aspects by the problem of target acquisition, we anticipate that technology will affect the character of urban combat more or less as described in the following discussion.

B.4.1. Penetration.

The qualitative model of a defensive posture in an urban context which we have considered consists of the following features:

a. Well prepared positions in concrete, stone, and masonry buildings (but seldom in inflammable structures) manned by two to eight troops (and occasionally as many as 40 or more troops in major buildings).

b. An array of such strong points forming what is basically a perimeter or linear defense but with some degree of depth and with fall-back positions partially or wholly prepared and provisioned.

c. Mortar and artillery support available but not extensively used because of the difficulty of observing fire.

d. Armor support available but not extensively used due to the difficulty of maneuver and the inherent risk of using armor in locales where antitank weapons operating at point-blank ranges may be encountered.

Given a penetration of this perimeter, the attacker is likely to encounter relatively little opposition but is still unable to exploit his newly gained advantage rapidly for fear of (1) encountering entrapments staged by the enemy's reserve forces and/or being subject to their counterattack and (2) the vulnerability of his lines of communication when such are channeled and proscribed to the degree found in urban combat.

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For the purpose of stimulating technical innovation, we assumed that today's basic tactic of frontal assault on the perimeter followed by house-to-house and street-by-street small-unit combat would be abandoned if new and improved equipment of proper nature were available. The capabilities that would be needed to justify this change in tactics consist of a means of entry into the city other than by frontal assault, sufficient autonomy of forces that lines of communication could be abandoned (for at least an interval of time), and a variety of means whereby buildings and areas could be bypassed without excessive concern of being entrapped or ambushed.

We have considered entry by enflankment and penetration from the rear, covert entry by Special Forces troops, entry by subterranean means (through tunnels under land, or under water if the city is located on a lake, river or harbor), and by air. When special tactics are possible (i.e., enflankment), they should be used, and for this possibility we do not find any specific equipment developments indicated. The success of covert entry into towns and cities can probably be enhanced by technology, but we do not consider this technique to be useful except in special situations. Subterranean entry has been considered and discarded on the basis of its excessive demands for large, expensive, and specialized earth-moving (or underwater) equipment. There remains entry by air and, in concept, this is applicable to the general problem, is potentially improvable by technology, and requires equipment likely to be useful for non-urban situations as well.

We do not believe that the application of the same skills which have conveyed delicate instruments to the moon's surface and remotely operated these instruments for many weeks cannot readily produce a number of alternative ways in which troops (who are quite rugged in comparison with instruments) and materials can be landed on a designated instant of time. While helicopters can perform this feat at present, alternative ways of providing for vertical entry are highly desirable for tactical flexibility and for use when the enemy's air defenses deny the use of helicopters (we anticipate that by 1985 precision all-weather operations with helicopters will be routine, but we doubt that the noise and visibility of helicopters can be reduced to the degree needed to avoid premature disclosure of the attack to the enemy).

Guided parachute delivery of men, with quick disconnection of the parachute on landing, is patently feasible and practical. This neglected area of development should be given priority and should include studies in which the paratrooper is and is not provided with a protective capsule.*

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* A start in this work has been made; see "Halo".

Another approach is to use individual machines such as the "flying belt" and its derivative and related vehicles. The study group has serious reservations about this approach, based upon what appears to be a rather basic range-payload limitation for these machines, the vulnerability of the trooper while flying at low altitude over rooftops, and the question of the trooper's confidence in his skills in finding his landing point and in landing in anything but the most favorable conditions of weather and visibility. However, we recommend continuing search for improved propulsion means for these machines, since all the problems cited can be reduced or eliminated if better means of propulsion are found. Then the individual machine can be equipped with instrumentation and either fly higher and faster, or be equipped with protective armor to reduce the vulnerability of machine and operator to ground fire.

One of the problems of vertical entry to the city using either helicopters or paratroops is a relative scarcity of suitable landing points (e.g., open parks and boulevards are sufficiently large and strong flat roofs). One means of solving this problem would be to use a landing mat suspended over a number of roofs. For this mat, the superstrength cables previously mentioned might be needed (but it is also possible that nylon and glass fibers now available would have an adequate strength-to-weight ratio).

A rather different approach that is highly speculative but appears feasible is to tie a circling, fixed-wing, cargo-type aircraft to the ground with a long tether. While there are several ways in which this tether might be connected, assume that the cargo aircraft flies a shallow pylon turn about the desired landing point at an altitude sufficient to be above the range of surface-based air defenses.* After establishing the pylon turn, the aircraft can launch a guided missile to tow the tether to the desired "drop point" and upon impact a "dead man" anchor would be deployed. Presumably, means can be found to damp the inevitable whipping of the tether to a tolerable level so that men and material can be released in capsules to ride down the cable using the cable to slow their descent to safe landing speeds. Variations on the proposed concept lead to a means of evacuating wounded troops by air snatch by an aircraft at medium to high altitude.

Cables of high strength-to-weight ratio are desired so that the strength of a long cable is not exceeded when loaded by itself, air drag, and the descending capsules. The superstrength materials seem ideal

* We readily admit that the concept to be described is more applicable to situations in which 5000 feet is a "safe" altitude than for higher altitudes.

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for this purpose since a 1/8-inch cable weighing about 0.02 lb/ft (assumed specific gravity of approximately 4) has a theoretical breaking strength of about 60,000 pounds.*

A number of variations on this basic concept are possible (and, in general, are more dependent than the orbiting aircraft version on the availability of strong, light cables). If a high altitude, tethered balloon could be located with tether points on opposite sides of the drop point, the use of synchronized winches would permit precision drop and pickup of payloads within a defended perimeter. Obviously, high lift helicopters and tilt-wing or tilt-fan aircraft could be used as well as balloons.

Finally, missiles and single-use conventional aircraft (either gliders or propelled aircraft) could be used to provide vertical entry.

Considered superficially, costs tend to inhibit serious study of the speculative approaches that have been described. While there can be no doubt that the minimization of the cost (in both lives and dollars) of tactical warfare is an imperative necessity, the proper perspective for considering costs is the comparison of the cost frontal assault with the cost of alternative means (such as vertical entry). Since it is impractical to attempt the estimation of these costs, a more limited comparison which might still remove the basic cost inhibition would be between the number of main battle tanks that might be lost when the perimeter defense is at maximum strength and when the defense is weakened to counter a threat to rearward areas.

B.4.2. Supporting Weapon Fire.

During the next decade, the Army will surely develop an accurate means of delivering weapons launched from the surface and from aircraft. Several forms of guidance now exist for achieving CEP's as low

* However, the development and use of the proposed tether landing technique need not await the availability of superstrength materials. Taking high-strength steel at 400,000 psi, the cross sectional area of the cable must be increased by a factor of about 15 to account for the differential in material strength and the dead weight of the cable. Thus, a 1/2 inch cable weighing about 0.5 lb/ft would have a payload capacity of about 60,000 pounds if 5000 to 8000 feet in length. No safety factors have been included for either conventional or superstrength cable, nor have wind loads. For these reasons, the steel cable is probably useful at the suggested lengths but would not likely be suitable for either longer tethers or heavier payloads.

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as 2 to 3 feet (i.e., command guidance using a stabilized sight and partially automated tracking, trackers, electro-optically gated to TV and semiactive laser guidance), and other techniques based upon the use of a radar beacon as an offset aim point should produce nighttime and all-weather guidance accuracies of 10 to 20 feet within the near future.

None of these accurate-guidance techniques offers, per se, any solution to the target-acquisition problem. In the context of urban combat, the infantryman will be able to call for precision fire on the strong points he encounters but, in general, he must draw fire to find the target. If precision fire support is available in adequate quantities, the defense will be forced to rely even more than at present on two and four-man defensive teams to avoid concentrations of men and weapons which would be worthwhile targets for indirect support weapons.

In terms of the operation of armor in cities, we do not foresee that these accurate, indirect fire weapons will have much effect. A future enemy will likely make use of recoilless rifles and guided weapons such as TOW (Tube-launched, Optically-tracked, Wire-guided weapon) to defend against tanks, and the discovery of such weapons in well-prepared positions will either be by an infantryman or by the appearance of a tank to draw fire. In neither instance is it evident that armor could lead rather than support the action.

B.4.3. High Firing Rate Short Range Weapons.

Because urban fighting is characterized by small-unit actions at close ranges, there appears to be a continuing need for light (portable) weapons for the individual infantryman. If necessary, accuracy can be sacrificed for high rates of fire and for portability.

The panel has not found specific instances wherein the new technologies previously discussed stimulate innovative approaches to this problem. We do, however, envision that methodical examination of the problem can yield significant results. For example, fighting within buildings could be an excellent situation for the use of fuel-air explosives (FAE or FAX).

B.4.4. Armor.

While it is not anticipated that heavily armored vehicle operation in urban combat will significantly change (see prior remarks on accurate, long-range weapon delivery), the question of light armor protection for vehicles and men should be an item of continuing investigation and development. It seems quite probable that significant evolutionary improvements in light armor will be possible and this may have major impact on fighting in streets and buildings.

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B.4.5. Small-Unit Combat.

In general, new weapons, night vision devices, and other sensors for the infantryman, and the probable development of remotely operable intrusion/motion sensors appear to favor the defense more than the offense (assuming that both offense and defense are equivalently equipped). It seems reasonable to anticipate that the well-equipped defender will be very hard to surprise (and that he will be better supported by the commitment of reserve units), but on the other hand, defensive positions will be rather dangerous for continued occupancy after the position is compromised. (The discovery of a defensive position is guaranteed when the defender fires on approaching troops).

The general trend in small-unit operations in city fighting thus appears to be toward fluidity and movement. It seems probable that the exchange ratio will increasingly favor the defense, but if our guess that a defensive position will not be tenable after discovery is correct, it also appears that a city cannot be defended except by counterattack.

From a general and historical viewpoint, no major change (except in degree) is anticipated in small-unit urban combat. The defender has the option of yielding the city and exacting a heavy cost or of trying to hold the city through a mixture of strong-point defense and aggressive and well-timed counterattack.

B.5. Psychological Considerations in Urban Conflict.

B.5.1. Objectives of Urban Conflict.

In the final analysis, the objective of conflict is to create the psychological conditions within the opponent to cause him to "lose" by:

a. Withdrawal of forces.

b. Surrender of individuals or forces.

c. Annihilation.

B.5.2. Characteristics of Opposing Forces.

a. Defenders of a town.

(1) Specifiable courses of action within the town (prepared positions).

(2) Relatively unrestricted mobility.

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(3) Knowledge of the terrain.

(4) Knowledge of the attacker's avenues of approach (target acquisition).

(5) Good control through plans and/or communications.

(6) Concealment with predetermined avenues of fire.

b. Attackers of a town.

(1) Limited knowledge of terrain and defensive positions.

(2) Reduced mobility (foreward).

(3) Reduced target detection sensing capabilities.

(4) Reduced effectiveness of firepower against defended concealed positions.

(5) Limited command and control (through plans and/or communications).

The list of characteristics of attackers and defenders is not exhaustive; however, the implications are suggestive.

B.5.3. Mechanisms for Achieving the Objectives of an Attacker.

The possible mechanisms of defeat:

a. Disclosure of the defender (target sensing).

b. Denial of protective barriers (attempted destruction).

c. Denial of channels of communication (impeding defenders mobility and interfering with his means of command and control).

d. Out-flanking.

e. Psychological techniques oriented toward the individual defender or the general populace.

The remainder of this subsection addresses itself to the psychological functions of the individual attacker or defender along with a few (and partially unrelated) observations of problems in which psychology interrelates with possible weapons, equipments, and tactics.

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The individual may be characterized, for our purposes, as a system of four interrelating subsystems.

a. Sensing system--totality of available senses.

b. Processing and storage--decision-making central nervous system.

c. Motor system--represents the complete response repertoire of the system from walking to talking.

d. Maintenance support--metabolic sustenance of the other systems.

Defeat of sensory systems. The visual system is the primary channel for the acquisition of environmental data. The defeat of this system in combat reduces the effectiveness of the individual to near zero. The degradation of this system results in a proportional degradation in sensing capability.

Specific mechanisms. High intensity ultraviolet radiation is capable of reducing the transparency of the corneal surface, resulting in reduced resolution. The process is time-dependent and not applicable immediately. Secondary effects, such as internal eye irradiomas, are not too well known. The eye's retina can be damaged by radiant energy exceeding 10^{-7} Joules of laser energy delivered to the corneal surface. It could produce localized burns if focused by the eye on the retina. In addition to the burns, the eye will be temporarily blinded by the bleaching of visual purple; however, recovery from this bleaching is reasonably rapid.

Temporary disruptive mechanisms.

a. Creation of a visual barrier such as smoke, dust. This reduces target acquisition range.

b. In confined areas (rooms), the release of a pupilary dilant in aerosol form can reduce visual efficiency by interference with resolution and by sensitizing the retinal surface to light.

Auditory. Audition is the second most important sense for the acquisition of environmental data. Ear drums can be ruptured by the delivery of one psi in the auditory canal, resulting in a temporary deafness (over a long time function may be recovered). Pain can be induced by the delivery of acoustic power of the order of 150 db at the ear. In addition to pain, a temporary threshold shift will occur.

<u>Vestibular (consisting of semicircular canals and atolith organs).</u> It is suspected that these organs are interfered with by exposure to high-frequency radiation, which may disrupt gravity- and acceleration-sensing ability.

<u>Skin sensors.</u> Nerve endings in the skin make up a diffuse sensory system responsive to temperature, mechanical distortion, wetness, etc. As a sensory system it can be irritated.

<u>Olfactory.</u> Sense of smell is intimately associated with gustation (taste). Adaptation to odors is rapid. Noxious odors, i.e., ammonia, are effective in high concentration. The use of noxious odors could be effective in some circumstances.

<u>Combinatorial sensory effects.</u> Pulsing lights produce interaction of vision and vestibular mechanisms to produce disorientation and nausea. High-frequency noise provokes an antinoise nervous response, resulting in muscular contractions.

<u>Central nervous system.</u> The outstanding attribute of the human is the reasoning process of symbolically manipulating ideas and concepts to arrive at conclusions. There is an active attempt on the part of the human organism to order its universe in an attempt to operate effectively. At the same time, the organism is a passive recipient of stimulation which affects its behavior perhaps unknowingly. (Example: propaganda, new ideas, etc., conditioning.) Given conflicting information and stimuli, the central nervous process undergoes alterations; that is, it will fatigue, and hence manifest a reduction in efficiency, e.g., inability to integrate masses of sensory data, reduction of memory recall, susceptibility to hallucinatory phenomena. In order to utilize psychological techniques, it is mandatory that the cultural base of the subject population be known. We perceive the universe through real data (sensory information) operated upon by ego structure, attitudes, motivations, etc., which have been programmed by the culture. In general, we probably know more about psychological techniques as applied to our own population than to any other population. We must, therefore, undertake to gather and collate sociological and psychological data for those areas whose people which present the greatest threat to us. These data can then be nipulated to explore the techniques which show the greatest promise. For example, if the defender believes in reincarnation, a naive attempt to utilize some of the more obvious psychological techniques may be wasted effort. In the attack-defense situation, the defensive force has some associated probability of surrender, obviously depending on the conditions existing at the moment. The attacker obviously is attempting to change the nature of this probability

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through time. Suffice it to say that psychological techniques in the absence of threat accomplishment will probably be totally ineffective. What is it that will affect the probability of surrender of the defender?

a. Prior to the attack the chief defender is invited to review the capability arrayed against him to demonstrate the hopelessness of the situation.

b. The attacker having the initiative can determine when the attack will take place. Depending on the time constraints, the attacker may feint attacks to keep the defender in a high state of alertness, activation, or expectancy. These high states are considered to be fatigue-inducing. There is some speculation that receptivity to "propaganda" is heightened by fatigue.

c. If alertness can be maintained during the night, the judicious utilization of lights and noise can be employed. It has been reported that the psychedelic effects of randomly-moving colored lights coupled with a beat of low-frequency intensity variation can create changes in mood and perception, and such physiological effects such as nausea, vertigo, etc.

d. The preparation for an attack could be an awesome spectacle for the defender. The bulldozing of a barrier in front of the attacking force could reduce the initial advantage of the defender until the town proper is reached.

e. Weaponry, in addition to its threat, provides information to the enemy. Normally, the individual under attack perceives a relationship between weapon-delivery noise, projectile-in-flight noise, and the detonation of the projectile. The utilization of decoys which simulate in-flight noise which is not followed by projectile detonation would create confusion and a disruption of expectant relationships. A related example of psychological warfare might exist if the enemy knows that a Davy Crockett weapon delivery must be preceded by one or more spotting rounds. Hence, the spotting rounds could be used to effect dispersal of defending troops without firing the Crockett round.

Within-Town Conflict. The basic problems are target identification, the delivery of accurate weapons fire, and the maintenance of pressure against the defender. Sustaining pressure against the defender requires a day-and-night capability. NVD's (night vision devices) aid in the night capability; however, NVD's are fatiguing to the eye, and the

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effectiveness of seeing is reduced after about one hour. The defender in concealment fights through apertures which are difficult to hit with point fire. A shotgun flechette might increase the possibility of penetrating small apertures. A capsule projectile filled with a pupillary dilant material might be effectively used against personnel in small rooms. As previously mentioned, the dilated pupil reduces resolution and increases light sensitivity. Defender and attacker derive information about one another's general location through weapon-delivery noise. Silent weapons would deprive the opponent of this information and create doubt as to the numerical strength facing him.

Vertical Assault. Concepts of vertical mobility for the individual soldier are available, e.g.: that of the rocket belt. Before concepts like this are explored, much preliminary data are required, as follows:

a. Who could use such a device (i.e., would a fear of heights -acrophobia- disqualify a prospective user)? A problem of selection and classification exists and has not been investigated.

b. How long would training take?

c. What are the display and control requirements of such a device?

(1) Is an avionics package required for sensing height, time, full-flown speed, rate of descent, etc.?

(2) Does the vertical assault concept imply hands-off controls?

d. What are the safety requirements in the event of malfunction?

e. Is the concept too vulnerable for town combat?

B.5.4. Summary.

a. The objectives are clearly to influence an opponent.

b. To influence an opponent one should know the opponent and what might influence him.

c. Apparently the best means of influence is destruction of capability, materiel, and forces.

d. The potentially most humane methods available are not acceptable, i.e., the temporary anesthezation of personnel, but current prohibitions should not necessarily be considered to be permanent.

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APPENDIX C - ADDITIONAL ADVANCED MATERIEL CONCEPTS

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APPENDIX C - ADDITIONAL CONCEPTS

Additional concepts which, for one reason or another, were not accepted by the study group are compiled herein. The descriptions have not been as fully reviewed as we would have liked because of time limitations and the parenthetical nature of this appendix. In some instances there exists a degree of overlap between the individual discussions, and in other instances none of the thoughts expressed appear in the main body of this report. The intent in presenting this material was to provide a vehicle for publishing the work and throughts of individual members of the panel.

C.1 Combat Experimentation

Problem:

Quantitative data are required to provide a basis for development of doctrines, organizations, and materiel requirements for the "terrain" and other environments unique to cities. Minor adaptations from ordinary Army operational concepts appear to be eminently ineffective.

Concept:

Perform combat experiments of the CDCEC type under "city" conditions, observing and recording city combat data under actual conditions of conflict. Deduce from the analyses of these data the operational and materiel characteristics required to maximize city combat effectiveness.

Discussion:

CDCEC has not performed combat experiments under city conditions, and has no plans to do so. This omission represents a serious and growing gap, given the projected importance of city combat. The difficulty of performing such experiments is recognized. The pertinent physical characteristics of cities (and subsystems and elements) of a number of "classes" of interest would have to be identified. These would then have to be acquired for combat experimentation by constructing mock-ups or using available prototypes.

Suggestion:

Plan CDCEC-type experiments, determining a priority order in terms of utility value and costs.

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C.2. Firepower Source Locator.

Problem:

In the phase of the assault leading to obtaining and retaining a foothold, the location of the strong points of enemy fire is important to the effective deployment of counter-fires.

Concepts for Solution:

a. Locate indirect fire enemy weapons by the extrapolation technique now used in mortar locators (e.g., AN/MPQ-4).

b. Get information on at least the direction, and possibly the range of weapons from a two-dimensional flash detection equipment and coupled laser range finder.

Discussion:

a. The radar for this purpose would probably be of special design for the problem at hand. It would have to be closely coupled in time and location to a counter fire weapon aimed in accordance with data provided by the radar and processed by an associated computer.

b. This flash-detection equipment would indicate the azimuth and elevation of flashes. In line-of-sight cases, a coupled laser range finder would provide aiming points for counter-fire weapons. Its effectiveness would depend on the magnitude of propellant radiation and atmospheric lucidity.

Suggestion:

a. Feasibility of a specialized weapon-location radar for armored vehicle mounting should be studied.

b. IR target signatures on weapons should be determined and, if feasible, a vehicle-mounted, 2-dimensional, flash-detecting set with coupled laser range finder should be developed to be integrated with on-station counter-fire weapons.

C.3. External Detection of Personnel in Buildings.

Problem:

Determine the presence of humans in buildings, tunnels, basements, etc. (Local Combat Internal Reconnaissance - LOCIR).

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Background:

During the final phase of urban combat, troops are clearing areas with numerous buildings which may or may not be occupied. At this time, each building must be assumed to be occupied and checked as such. This increases the time required to move through an area. Human signatures, direct or indirect, have been reviewed and tabulated, and three restricting circumstances were postulated: (1) line-of-sight exposure of the target, moving or stationary; (2) a stationary target masked from direct line of sight by physical barriers normally found in an urban area, and (3) masked targets which move about in the building. It is considered feasible that present technology could develop devices which will enhance present capabilities for determining humans located in buildings who are in optical line of sight. This could improve identification in low light areas and during times of low illumination.

Determination of the presence of stationary humans behind buildings or other material barriers is highly problematical with present technology, but the state-of-the-art does show some promise in determining human presence behind barriers as the humans move about within the building. Possible approaches can be hypothesized now but the necessary equipment does not now exist.

Suggestion:

It is suggested that a feasibility study be conducted to determine the rationale for the development of a LOCIR, and that search be made of present technology to determine present capabilities or possible approaches within the 1975-1990 time interval. This should have long stand-off capability -- 1000 meters.

C.4. Wall Breacher.

Problem:

During the systematic clearance of defended urban structures, the normal areas of approach are limited and predetermined.

Background:

The physical layout and construction of the urban area tends to channelize movement through the area and hence, the approach to individual defended positions. For this reason, the defenders have a decided advantage in that they can establish predetermined, overlapping fields of fire from mutually protective defensive positions.

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In assaulting such a complex of positions located in urban structures, it would be preferable to move <u>through</u> a series of buildings (i.e., a city block) instead of approaching each position from outside. Advance through a building may be inhibited by solid walls; even where doorways exist, they may be blocked or separately defended. Present means of breaking through interior walls include the use of hand tools (which is time-consuming and laborious) and conventional demolition charges (which are relatively inefficient on a weight basis, are noisy, and may result in undesirable structural damage or collapse).

Concept:

Light-weight, sectional, wall-breaching demolition charges should be supplied to the assault troops for use in blowing man-size holes through interior walls ranging up to 8-inch-thick concrete, or the equivalent. It might be possible to adapt or modify existing tree-cutting, linear-shaped charges to perform this function.

Tactical Employment:

Sections of linear cutting charge are carried to the point of use and assembled into circular or hexagonal shapes which could be fastened or propped against the wall. A short delay fuze is actuated and troops retire to nearby cover while the hole is blown; troops then advance (or attack) through the hole. Use of such small demolition charges should reduce the blast and fragmentation effect on the friendly side of the wall and reduce the possibility of dangerous collapse of the structure which would result from the detonation of relatively large, inefficient charges in the interior.

Suggestion:

a. The need for such a wall-breaching demolition charge should be investigated by CDC.

b. If a requirement exists, the possibility that an existing linear cutting charge can be modified or adapted to perform the wall-breaching function should be investigated.

c. If existing materiel cannot be so adapted, a special wall-breaching demolition charge should be developed.

C.5. Barrier Weapon.

Problem:

To obstruct or channel the defender's movements and his re-supply elements at critical times.

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Concept:

The proposed materiel concept described is meant to complement or displace to some extent the family of mines designed for the conduct of barrier warfare. The idea represents an attempt to take the man's finger off the trigger of a gun. We desire to remove the man from the weapon-target interaction by providing an above-the-ground, controllable, unattended barrier.

The barrier envisioned is one consisting of a group of short range weapons, each of which is fixed in azimuth and automatically fired by a local IR sensor. The system relies on a passive acquisition and discrimination sensor for alerting an array of weapons, each of which is independently equipped with a passive optical sensor along its line of fire. Upon instrusion, the weapon, loaded with a contact-fuzed warhead, is fired into the target at a distance of up to 100 meters.

Discussion:

The system involved tying together acquisition sensors for alerting and activating an array of fixed-azimuth, short-ranged, light-weight, large-caliber projectors, implemented with optical sensors which control the release of their warheads when armored targets pass through their line of fire. Such a system is technically feasible and requires no technological "breakthrough". Its basic features are controllability, reduced logistical burden, and reduced emplacement time over conventional mine munitions now in use or under development. The principal advantages of gun-fired warheads over buried mines are rapid emplacement, ease of retrieval, operational simplicity, and reduced logistics. The advantages are derived from the substitution of line of destruction for a point of destruction. In other words, the destructive agent is able to reach out to strike its target.

A sketch of the design concept of the lethal component of the barrier system is shown in Fig. 1. The barrier weapon illustrated is essentially two guns back to back with an adjustment that permits both barrels to be moved in elevation to account for local terrain irregularities. The weapon is a modified Davis gun which sends its projectiles in two directions upon firing.

C.6. Wire Gun.

Problem:

The "Wire Gun" technique provides a simple, cheap, silent, self-energized method for projecting a wire up to distances of 200 feet. Suitable problems in city combat operations which could be addressed might include:

a. Scaling of walls.

b. Bridging gaps (wall-to-wall, shore-to-shore).

c. Erecting barriers (barbed, sensing).

d. Ensnaring personnel.

e. Communications line projection.

Concept:

A technique has been developed at Frankford Arsenal for forcible projection of wire from a coil by using the energy stored in elastic deformation of the wire. A number of employment concepts have been demonstrated.

Discussion:

(See F.A. reports P60-5-1 and M62-19-1)

Suggestion:

Re-examine operational needs in city combat situations; describe functional needs; perform preliminary concept studies of devices for these functions; evaluate technical and tactical feasibility.

C.7. Short Range Communications.

Problem:

To provide means for small groups of attacking forces to keep in touch with each other at command levels in city fighting.

Concept:

Overcome radio noise, [illegible]g, saturation, and installation problems by simple but unorthodox means of communications that do not require elaborate installations. For instance:

a. Ultrasonic whistles for basic commands (dot-dash, etc.).

b. Seismic communications - in which one couples to the earth or the wall of a building.

c. Utilization of existing insulated conductors such as electric power outlets, trolley tracks, and power lines.

Suggestion:

Develop supplementary unorthodox communication systems for in-city fighting.

C.8. Air-Ground Communications.

Problem:

Provide a common air-ground forward-area communications channel and improve the information transfer efficiency of such a channel, especially for high-priority cross-net traffic alerts and emergency signalling between ground and air forward-area units.

Concept:

a. Develop a small, simple, fixed-tuned guard receiver to be incorporated in all future VHF/FM radio sets.

b. Incorporate a voice-operated transmission (VOX) in all push-to-talk combat radios to increase voice traffic flow, reduce carrier radiation, and improve isolation in voice security transmission.

Suggestion:

Incorporate above in future receivers.

C.9. Low-Signature Weapons.

Problem:

In town conflict one of the problems of the attacker is to reduce his disclosure to the defender. The noise associated with the firing of an individual weapon assists the defender in localizing at least the gross position of the firer.

Concept:

Supersonic weapons are characterized by:

a. Weapon delivery noise (expansion of gasses propelling the projectile).

b. The in-flight shock wave generated by the projectile. Demonstration silencers have been fabricated for the M16 rifle which reduced the associated delivery noises to approximately 40 db at 20 feet. Preliminary experiments have shown that localization of the delivery position, based on the projectile noise alone, is very impractical.

Tactical Employment:

Removable weapon silencers provide the option of suppressing or utilizing weapon delivery noise for its potential psychological significance. For example, it might be advantageous to deliver the firepower of five weapons but disclose the delivery noise of only one.

Suggestion:

That silencers be produced for use. Parallel research should be performed to determine the significance of delivery noise as opposed to ballistic crack.

C.10. Pupillary-Dilant Agent.

Problem:

To reduce the visual efficiency of defenders in a small confined space.

Background:

Defenders of a town will normally occupy rooms in the available structures for purposes of fire delivery, command posts, etc. Interference with their visual effectiveness would be disruptive in target acquisition; interpretation of displays, maps, written communication, etc.

Concept:

Development of a pupillary-dilant-filled projectile which, when fired into a room, would release the dilant in aerosol form. Pupillary delation interferes with resolution and increases sensitivity to light.

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C.11. Application of Infrasound.

Problem:

Any kind of reduced physical and mental capacity of the enemy will be of aid to us. The reduction in performance potential can be due to physical ill-being (nausea, heavy breathing, blurred vision, or hearing) or psychological effects (anxiety, sleeplessness, or sleepiness, general fatigue).

Background:

Some physical and psychological effects upon man produced by subsonic energy (0.1-16Hz) have been reported. However, no systematic and exhaustive study has been made yet.

Concept:

Subsonic energy could be projected toward enemy-held sites for a prolonged period of time (1 minute to 24 hours) to produce adverse effects upon personnel. Perhaps by changing frequencies and intensities, in conjunction with other devices (dissemination of fog, foam, ordnance) a state of utter exhaustion can be achieved.

Suggestion:

AMC should consider the initiation of a research program studying the production of high-intensity subsonic frequencies. This study should also include effects of subsonics on man as a function of frequency, intensity of the sound energy, and duration of the exposure.

C.12. Close-Range Target Identification.

Problem:

Due to fleeting exposure of targets at close range, the rapid and effective utilization of weapons is often tempered by the possibility that the target is friendly.

Concept:

Provide friendly units with secure, reliable, automatic, and instantaneous means to identify themselves when challenged by a device integral to the weapon to be used.

Discussion:

The need for a battlefield IFF system is expressed in para 1512b(7) CDOG. Based on an in-depth study, a program to develop radar-transponder-responder systems and optical, electro-optical (GUNN, laser, etc.) identification systems has been started. An alternate "bag of tricks" approach is also being pursued.

Suggestion:

Continue to expand battlefield IFF systems and devices development so that small, cheap, and reliable systems can be issued to all friendly units needing them.

C.13. New City-Entry Technique.

Problem:

Minimize casualties and materiel for assault on city.

Concept:

Tunnel in and surprise.

Suggestion:

Investigate tunnelling as a means to enter city, and thereby surprise and divert defending forces, and facilitate ground or air assault.

C.14. Building Surveillance.

Problem:

Determine whether building is occupied.

Concept:

a. Use animal "ferret" that will react to presence of individual (e.g., dog, wolverine, pigeon).

b. Toss in agent to provoke response (tear gas) and detect response (sneeze, cough) of toxic gas. Prepare to get occupant as he emerges.

Suggestion:

Study animal capabilities for such tasks.

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C.15. Attack of City Utilities.

Problem:

To attack enemy personnel capability for functioning.

Concept:

Contaminate the urban area water supply and dam its sewerage system.

Discussion:

Contaminants added to water supply and damming of sewers will cause nausea and other debilitating effects, rendering the enemy less capable of functioning.

C.16. Improved Grenades.

Problem:

Assault teams engaged in clearing defended urban areas, particularly buildings, consume large quantities of hand grenades. Grenades are used routinely immediately prior to entering buildings or rooms. Effectiveness of the assault teams can be improved by (a) increasing the number of grenades which can be carried and (b) increasing range and improving delivery precision (e.g. through openings, doors, windows).

Concepts:

a. Increase effectiveness per unit tactical and logistical weight--more grenades of adequate performance capability per pound.

b. Enhance rifle grenade performance (e.g., for M79 systems) by providing shorter arming distance and time delay options: shorter arming distances would permit attack of close-in targets which are expected more frequently in urban combat; time delay mode of fuze operation could permit penetration of light protective barriers (windows, doors) and enable the grenadier to evade fragments of his own grenade(to duck behind cover).

C.17. Movement Detector Dust.

An explosive material (e.g., PBA CTA) is microencapsulated and stored in a sealed container/dispenser with an inactivating

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solvent. The dust-like material is applied over an area which is to be denied to enemy troops. After a short time, the evaporation of solvent renders the microcapsules sensitive to detonation by [illegible]. Enemy troops attempting to move through the area cannot avoid [illegible] capsules, which detonate and alarm observing friendly troops. This should be especially useful in preventing night infiltration or re-supply movements. It has the disadvantage of similarly denying the treated area to friendly personnel. Instead of or in addition to the microencapsulated explosive material used for audible alarms, a visible signature might be obtained by microencapsulation of chemiluminescent or similar materials.

Problem:

It is often very difficult to determine the presence and/or the movement (infiltration) of enemy personnel through urban areas, particularly at night.

Background:

To detect enemy presence, and especially movement, devices to produce audible alarms or visible signatures should be developed.

Concept:

To produce audible signals one could disperse (by air, grenade, sprayer, etc.) microencapsulated explosive material which is pressure sensitive (lead azide, cyanuric triazide). Prior to application it should be stored in a sealed container/dispenser with a desensitizing solvent. The dust-like material is sprayed over the area to be denied to the enemy. Upon dispersal of the material the desensitizing liquid (Freon TF) evaporates, thus activating the microcapsules to pressure sensitivity. If enemy personnel step on these microcapsules, they detonate with an audible report.

To produce a visible signature on enemy personnel, aerosols of luminescent materials or microencapsulated chemiluminescent materals could be dispersed in areas to be denied enemy access. Enemy personnel would be "painted" with such material, thus becoming visible at night. For better detection, IR equipment with light intensification could be used.

Tactical Employment:

Audible and visible signals produced by enemy personnel upon encounter with microencapsulated chemicals can be utilized to detect enemy movement with a minimum of auxiliary detection equipment.

Suggestion:

AMC should initiate appropriate research as to the feasibility of these detection systems.

C.18. Factual Reporting to the Enemy.

In an urban environment, small enemy units may be in communication through a central radiotelephone network, but do not have any immediate access to a general picture of the situation. Therefore, it is more difficult to induce rout in a city, than in the countryside, where each soldier has at least some indication of the tides of battle in his immediate neighborhood, whether or not that indication is accurate. Thus it is sometimes necessary to kill or wound almost every defender in order to clear an urban area. This results in high casualty rates for both defender and attacker.

Factual radio and loud-speaker communication of play-by-play descriptions of the battle could perhaps promote surrender of defenders in a hopeless situation. This would lead to quicker victory, less destruction of the city and the combatants, and smaller expenditure of supplies.

Suggestion:

CDC should formulate and evaluate doctrine for use of a system for reporting factual information to enemy troops during the course of urban conflicts.

C.19. Chameleon Camouflage.

Problem:

During the attack phase, losses of the attacking force are often very high when the attack is directed toward an enemy holding urban sites. Attacking units usually blend into a rural landscape, but when they enter suburban or urban areas, their camouflage becomes a liability.

Background:

Losses by the attacking force might be reduced if it used "chameleon" camouflage, which permits change of camouflaging cover to blend into a new environment.

Concept:

Two possibilities exist to achieve "chameleon" camouflage:

a. Uniforms or capes are treated with photochromic dyes that change color (e.g., from green to sandy yellow) when exposed to light reflected from house walls.

b. Uniforms or capes are treated in such a fashion that color changes could be developed by incorporating into the fabric sacs of different colored pigments which can be expanded by the wearer. If, for example, the wearer wants to be colored green, he would squeeze a green bulb and the green sacs would expand, thus depressing the sacs of other colors. Entering a gray, sandy area, the wearer would squeeze a gray-controlling bulb which would expand the gray sacs, compress the green sacs, and the covering would turn gray. A brown-controlling bulb would yield a brown garment. Variegated patterns could also be introduced, as well as mottled patterns.

Tactical Employment:

Variable-color garments would be worn in situations where color changes of the garments would significantly improve camouflage of personnel, and one could reduce losses of attacking units.

Suggestion:

AMC should present this concept to its laboratories for studies of technological feasibility.

C.20. Sleep Control.

The exercise of some degree of control over an enemy's ability or desire to sleep offers the possibility of tactical advantage in protracted engagements. The urban environment makes it somewhat easier to "reach" the enemy with loud-speakers (though somewhat harder to reach him by other means). Also, the pace and duration of urban conflict and siege enhances the utility of sleep control.

There is available no systematic knowledge on intentional disturbing of sleep with sounds, noises, or noise plus action (such as exploding incendiary bomb). Some general conclusions can be inferred from available data: people adapt readily to noises of any type that are not associated with threat, but both the unexpected starting and the unexpected cessation of sounds are disturbing when the change may be related to a real or imagined threat. Finally, it is known that sleep patterns and requirements vary greatly with individuals, circumstances, motivation, etc.

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It is conceivable that loud noises masking battle noises will be disquieting to troops. It is also conceivable that monotonous or regular noises can induce sleep or sleepiness in a fair proportion of weary troops.

Despite the difficulties, it seems that some degree of control of sleep could be effected by a loud-speaker system installed and guarded from fortified positions.

Suggestion:

Army Research Office should start a program of research on sleep control in conflict situations.

C.21. Manmade Dust Clouds.

The defenders of a city are better concealed than the attackers, all other things being equal. This balance can be upset by exploiting the localization of the enemy, to make his situation less comfortable and to nullify his concealment advantage. One approach in this direction is to generate dust clouds over the city. This would require gigantic "siege engines" to dig up, pulverize, dry, and disperse dirt, sand, or soft rocks. The energy requirements to produce and spread enough dust so that upon settling it would collapse all but the strongest structures, are smaller than those necessary to destroy structures by explosion of bombs and artillery projectiles (non-nuclear). Even before that amount of dust is spread, very unpleasant, low-visibility conditions will prevail. Visibility could be so restricted that attackers could walk (blindly) without detection. This situation would also favor the more intensively mechanized force which could use millimeter wave imaging or pulsed lighting/gated viewing techniques to "see" through the dust storm. The dust would not work during high winds or rain storms.

Suggestion:

CDC should consider "siege engines" of the dust-producing type described.

C.22. Enhanced Sound-Tracking Capability.

It is technically feasible to provide increased capability to combat units to determine the direction toward the source of characteristic sounds such as muzzle reports. There exist three distinct avenues of approach:

a. Improved direction sensing for the individual through hearing-aid-type devices.

b. Crude, automated, direction-sensing devices with visual display.

c. Precision, automated, direction-sensing systems.

In the past, primary attention has been directed at the most complex task (item c) in an effort to achieve point-target accuracy for counterbattery artillery fire. Though technically plausible, devices of this type have not yet been made practical. In urban conflict, where pure infantry action predominates, the target acquisition problem is characterized by short ranges and the need for only sufficient accuracy to decide from which house or which window a shot was fired. Thus accuracies of the order of 100 mils would be useful. In this environment, the easier task of crude sensing of direction of a sound source becomes more interesting.

A man's auditory direction sensing is based almost entirely on the "parallax" of his two ears, rather than the difference in amplitude of signal associated with the fact that his ears are facing in different directions. This can be deduced from the fact that direction sensing is degraded in hot weather and almost obliterated underwater, because increase in sound speed reduces the difference between the times when a signal affects the two ears. With a system of this type, accuracy increases directly with the distance between the two sensors. Consequently, putting a hearing-aid microphone at the end of a boom a few inches in length and inserting the speakers in the ear to block out direct acoustic waves would improve direction sensing. The amount of improvement obtainable without requiring long training or adaptation would be at least equivalent to that obtained in subzero temperatures with the unaided ear. Perhaps even better resolution (longer boom) could be achieved without excessive training. A simple adjustment of the boom length would provide compensation for air temperature variations. Using a hearing aid on each ear would permit the inclusion of circuitry to gate out all sounds for a brief period following a loud report. This will reduce confusion from reverberations from buildings, because the line-of-sight path is shortest and the direct wave will always reach the observer first.

Any number of means are available to provide crude, automated, direction sensing of sounds. For the stated accuracy of about 100 mils, a device of the weight and cost of a transistor radio would suffice.

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Suggestion:

CDC should consider the utility and needed degree of accuracy of direction sensing of sounds in urban conflict. Also, consideration should be given as to whether hearing-aid-type or automated-type gear with visual display is preferred.

CS & TA and ECOM should build and test breadboard prototypes of the two approaches to provide some experience in this area.

C.23. Sniper Locator.

Problem:

The urban area provides numerous protected points for sniper operations. The sniper is only momentarily exposed and can operate with relative security from detection, even from a single position, whereas many possible sniper positions must be monitored by the attacker.

A means is needed to detect and determine the direction of sniper fire, to focus the attention of attackers on sniper nests, and to force snipers into greater exposure in moving from position to position.

Concept:

Develop a more portable short-range doppler radar with wide field coverage, computer, and remote display to indicate directions of enemy sniper fire.

C.24. Catalog of City Characteristics.

Problem:

The information available to the defender on the environment of an urban battlefield is nearly always better than that available to the attacker. If this differential could be reduced or eliminated, a major advantage of the defender would be degraded, if not entirely eliminated.

Background/Discussion:

Defenders of urban areas can be assumed to have studied the area and selected their positions to take maximum advantage of the urban environment. On the other hand, typically, the attacker has only the most superficial information on the terrain of the city. In many

instances, the only information available to the attacker consists of city maps, often of doubtful reliability. Even if air photographs are available, rapid interpretation normally yields only information on street patterns and the general exterior configurations of the buildings. In contrast, the attacker also needs information on the type of construction of the buildings (stone, reinforced concrete, brick, wood, etc.), the pattern of the interiors (how many rooms, the arrangement of rooms and hallways, locations of elevator shafts and stairwells, etc.), the locations and characteristics of subsurface connections (sewers, utility tunnels, subways, etc.), and the locations and characteristics of key distribution points for electricity, water, gas, etc. If the attacker had even partial knowledge of these characteristics of the city, the advantage of prior information available to the defender would be seriously reduced.

Concept:

A considerable emphasis is currently placed on the requisition of military geographic information and its processing into suitable forms of intelligence for use by the field armies. Although data on cities are collected, it is doubtful that adequate emphasis is placed on such data. It is therefore proposed that a catalog of city characteristics be compiled, analogous to those for more classical geographic information.

Several subordinate problems can be identified. These are identified and briefly discussed in the following subparagraphs:

a. Identification of significant items of data. The general character of urban conflict should be systematically studied in order to determine the specific characteristics of a city which should be included in the catalog. For example, is it really significant to differentiate between a structural steel and a reinforced concrete frame? To what level of reliability should the thicknesses of masonry or concrete walls be measured?

b. Data acquisition. A deliberate program for acquiring the required data by conventional means should be initiated. This would include increased emphasis on acquiring city data by in-country attachés, intelligence personnel, and the like. Collection should also, however, include a program to learn how to interpret conventional air photos in terms of the factors revealed by the study hypothesized in item a above. Further, the feasibility of developing special non-contact sensors to obtain information on the properties of buildings.

For example, it may be possible to sense the locations of stairwells and elevator shafts by remote means. The possibilities should be investigated.

c. Data storage. The proposed catalog will, when fully established, contain an enormous amount of information. A way to store these data in systematic and internally consistent form will have to be found. It is obvious that only by the full exploitation of ADP systems can data in the amounts required by the problem be expeditiously manipulated.

d. Data referral. A way to interrogate the data file for specific information about a particular place must be developed. Again, ADP machines are obviously essential.

Tactical Employment:

The tactical employment of the city catalog is visualized as follows. A commander is faced with the necessity for seizing and controlling an enemy-held city. He anticipates that the city will be tenaciously defended. In order to plan the assault, he calls upon the city catalog to provide him with essential information on which to base his plans. The catalog may be in a central location in the homeland (the size of the required facility will probably make this mandatory), in which case the request for information will flow by radio communications channels to the catalog. The ADP system will receive the inquiry, search automatically through its files, assemble all information considered pertinent, and transmit it to the user in some previously established standard format. Data outputs can be envisioned as tables (e.g. types of construction of buildings), diagrams (e.g. generalized building floor plans), or maps (e.g. planimetric map of the city subway system). All of these can be produced by on-line output devices, either at the central facility or at the user's communication terminal. On the basis of the data received, the commander plans his assault, estimates his personnel and munitions requirements, and so on.

Suggestions:

The following interrelated suggestions are made:

a. Combat Developments Command should intensively study the nature of urban conflict, with special attention to different types of cities (see para 3, sect II), to determine the attributes of cities which significantly affect operations therein, and with a view to establishing the level of information detail which will be required.

b. Army Materiel Command should initiate a program to investigate the feasibility of noncontact sensors for acquiring data on city construction characteristics.

c. Defense Intelligence Agency should initiate and maintain a more intensive program for acquiring data (as revealed by the CDC study recommended in item a above) on cities by conventional intelligence-gathering procedures.

d. The Corps of Engineers should initiate the development of a suitable modification of the data storage system currently being developed for conventional military geographic information. The adaptation should be capable of accepting and filing data on cities.

e. The CDC should initiate a study to determine the optimum information output formats for city data, to be used by the field army.

C.25. Violence Incident Analyses.

Introduction:

Despite the difficulty of this task and previous failures to produce a useful result, it is essential that experience in urban conflict be collected, categorized, quantitatively characterized, and analyzed. The only alternative is to repeat the errors of basing our operational and materiel needs on random and subjective anecdote and conjecture.

This is offered as a suggestion for future Army studies; obviously, it is beyond the scope and capacity of the present working group except for the suggestion that it be done--and general description of a method for doing it.

Method:

a. Urban Conflict Analyses. Records, reports, and studies of urban conflict in selected countries (not excluding U. S. A.) will be collected as a step forward defining operational and materiel performance requirements. It is recognized at the outset that such information will be incomplete and erroneous to some extent. Nevertheless, some limited effort should be made to use these records of experience to characterize and categorize urban conflict at various levels of conflict intensity. The findings should serve also as a basis for recommending to the sources of such records--military forces,

national police, local police--additional data elements to be included in future reports of conflict. This could be useful in future re-assessments of materiel and force requirements. The information collected will be analyzed and evaluated systematically as follows:

(1) Threat Analysis. Identify and describe the spectrum of offensive and defensive threats in terms of magnitude, frequency distribution, geographic distribution, operational modes, degree of organization, source and level of motivation, dependency on external and local support, trends and predictions--at several levels of conflict intensity.

(2) Target Analysis. Determine characteristics of principal target types such as personnel (group size, protection, organization, mobility, weaponry, availability of reinforcing elements) and materiel (vehicles, supplies, communications, and other equipments)--to provide an experience basis for ranking defeat mechanism effectiveness.

(3) Engagement Conditions. Describe quantitatively the conditions of engagement among combatants in terms of frequency distribution of target ranges and sizes, target types, combatant and target intervisibility, types and effects of natural and man-made obstacles, day vs night operations, other environments and their effects --to provide a basis (for extrapolation) for performance requirements for detection, communication, mobility, and firepower.

(4) Defender Characteristics. Describe the capabilities and limitations of the defender (military, paramilitary, and irregular forces) in terms of trainability, susceptibility to organization and control, motivation, physical characteristics.

b. On-site Observations.

(1) Observer Teams. Provide trained observers to make first-hand observations at the scene of reported and current conflict in selected locales. It may be necessary to employ members of U.S. military forces to assist in this, perhaps in the capacity of advisors. Immersion of some observer-team members into the environment may be required to avoid the sterility of an "ivory tower" study--to insure reality of the collected information. This task will involve observer team visits to selected areas in which urban conflict has occurred and is occurring to obtain a fuller appreciation of the conflict characteristics and its environment.

(2) In-Country Forces. The country's military, para-military, and irregular forces would be solicited to assist in the collection of additional urban-conflict data. By educating these elements in the goals and methods of the study, it should be possible to improve significantly the further collection of data. They would be instructed in "what to look for" and, perhaps, be assisted by providing data check-lists both for their own observations and for interrogation of prisoners, combatants, and by-standers. Although these procedures cannot be expected to eliminate the data inaccuracies and gaps, careful analysis should provide useful additions to the data "bank".

Both of these methods will help to validate or qualify previous and subsequent reported data and to fill gaps where specific data are needed.

C.26. Systematic Study of Possible Defeat Mechanism for Urban Combat.

Topical Outline:

a. Physical Protection. This would include the obvious man-made and natural barriers to attack and observation, like walls, barricades, visual screens, vehicle and body armor, CB filters, terrain features, radiation masks--in short, the objects and energies interposed between their critical functioning elements and our attack devices.

b. Firepower Devices. These, of course, are the most difficult to degrade, thwart, or countermeasure.

c. Sensors. These would include "listening" devices for signatures of our presence or activity--and could cover the spectrum from string-and-tin-can arrays to body sniffers and seismic and radiation detectors.

d. Communications. This is related closely to sensory systems (c) and also involves the intra-defender communications--both within the defended area and to their outside support elements. It, too, can run the gamut from visual signals and messengers to electro-magnetic systems.

e. Life Support Items. These would include food, water, shelter, power--both within the defended area and in re-supply from without.

f. Mobility. These include the avenues and devices for movement of persons and supplies--surface, air, and subsurface.

Parameters of Interest:

a. Functions. For each target class and specific target, describe the operational function and evaluate the utility to the defender. Admittedly, this (utility value) is difficult to assess, but a value ranking could be useful to further study. At the very least, it could help prevent dissipation of effort on "pet projects"--avoid using the sledge hammer to kill the gnat.

b. Signatures. Identify and quantify the target characteristics that distinguish it from the environment, that could enable locating it. These would include detection in all sensible areas: visual, auditory, seismic, olfactory, electromagnetic, etc.

c. Location and Distribution. Inputs to this would come from direct sensing, indirect intelligence, and prediction from past experience or speculation. The value, in terms of the present study, should be realized as it affects (a) an appreciation of the "delivery" requirements and (b) the priorities of attack objectives. For example, if we find that every defender and each item of his essential materiel are concealed and protected by a brick wall, then a high priority would be put on the defeat of brick walls--by brute-force destruction, permeation, by-passing, or otherwise.

d. Materials and Dimensions. These characteristics of the targets of interest need to be known to focus our attention on the requirements for detection and defeat. (The definition of "defeat" encompasses degrading, thwarting, and countermeasuring.)

e. Time to Emplace, Displace, Operate. This is another target parameter essential to establish defeat criteria. Target attack concepts should not be limited to instantaneous effects. Action and reaction time of the target can influence markedly the defeat approaches worth considering. For example, it might be operationally feasible to "rust" out or saturate a fixed communications center, but a mobile one needs to be "knocked" out promptly.

f. Operating Personnel Requirements. This is a target system characteristic that, if properly evaluated, can offer defeat mechanism alternatives. Ignorance of this could constrain the approach toward an unnecessarily hard target. Since the real goal is to degrade or thwart function, the total target system view should be taken.

g. Operating Materials, Environment, Power. (Same comment as f above.)

h. Effective Range and Duration of Operation. This is related to e above. It is a property of the target that has a bearing on its detectability and availability for the attacker and on the utility value for the defender.

Vulnerabilities:

a. To Degraded Function. Identify and quantify the nature and extent of damage to produce various levels of function degradation. Compare these with all the "costs" of delivering the damage and with the utility value for the defender.

b. To Thwart Function (Operational). What are the operational changes the attacker can take to make himself less vulnerable to the unimpeded function of the target system?

c. To Countermeasures (Physical). What protective or offensive measures can the attacker take to render ineffective the target's undegraded function?

C.27. Research in Psychological Warfare.

Problem:

To develop a better understanding of how the attitudes and motivations of defending forces can be changed through the selective dissemination of information and the best techniques for the dissemination of such information.

Background:

Psychological Warfare, through dissemination of propaganda, has been employed throughout the ages in attempts to sway populations. The effectiveness of psychological warfare is difficult to assess, at least in the short span of time. At best, the basic requirement for the application of psychological warfare is a complete knowledge of the cultural, social, and psychological makeup of the population under attack. While its potential is great, the nature of psychological warfare in terms of form, content, timing and methods of dissemination to bring about a desired effect on a particular population is at best ill-defined.

Approach:

If not already in progress, an analysis should be performed of historical psychological warfare applications in terms of representative populations, "message" content, timing, and methods of dissemination to attempt to extract commonalities and/or differences along the stated dimensions. In addition, attempts should be made to specify under what conditions a given population may be influenced by various techniques. What techniques are most effective prior to attack as opposed to during attack? Are individuals more susceptible to psychological warfare under conditions of fatigue, i.e., early evening as opposed to early morning?

Parallel to the analysis there should be a method established for the documentation of significant current cultural, psychological, social, etc., conditions describing selected foreign cultures in an attempt to determine their vulnerability to various forms of psychological warfare.

Finally, all weapons of war have two aspects, viz, lethal and psychological. An analysis of the potential psychological effects of various lethal weapons should be made in an attempt to exploit their individual or combined effects on a defender.

Various attempts at use of psychological warfare were suggested to the committee. However, it was apparent that there is a lack of basic knowledge of factors which make defending troops susceptible to psychological influence and the means for exploiting each weakness. Therefore, the committee could only endorse further study to establish the basic approaches to psychological warfare.

C.28. High Accuracy Indirect Firepower.

Problem:

In many situations, forward observers, both airborne and on the ground, detect targets and call back to heavy weapon support units for fire. Due to inaccurate determination of target position, round-to-round variations in projectiles, and variations in atmospheric conditions, the probability of hitting a target with one round is low; multiple rounds and saturation fires are required. This is expensive in terms of direct dollar costs and indirect costs like the delay in neutralizing enemy targets and the burden on the logistic support system. It is quite hazardous when friendly besieged units have to call fire down on close-by enemy positions. Not infrequently, friendly units in effect "call fire down on themselves."

What is needed is a way to put the first round on the target.

Concept:

A family of systems that will enable a forward observer to "tag" a target he designates for attack by a heavy support weapon. The tag would present a unique radiation signature against the terrain background for the homing of an aimed projectile. Two possible "tag"-homing missile systems are:

a. A forward observer or besieged unit calls to a support battery the best estimate of the position of a target designated for attack. After coordination with the support unit, the observer or besieged unit fires a tag round directly at the target. The tag can be a radio beacon, coded if desired, with a relatively short lifetime. The support round is launched in the approximate trajectory to hit the target. As it closes, the round acquires the beacon (tag) and homes on it.

b. Using the best available estimate of enemy position, the attack round is launched. On a pre-arranged signal, the forward observer activates a laser illuminator (preferably invisible) which he has aimed at the target. The incoming round homes on the "bright" spot.

The support of development of these type systems by the Army should provide equipments of greater utility for urban conflict.

C.29. Improved Flame and Incendiary Weapons for Use in Cities.

Problem:

Develop basis for improvement of flame and incendiary weapons to increase firepower for offense.

Discussion:

In the recent past, considerable research has been conducted on the energy releasing properties of flame and incendiary materials and on methods or vehicles to deliver the materials to the targets. Little information is now available on how to evaluate flame weapons.

Flame weapons have been used as a "last resort" against hardpoints such as those found in attacks against cities, and the committee considered improved flame (and incendiary) weapons desirable. However, it was recognized that there is a lack of vulnerability data for the effects of such weapons against personnel and materiel targets. Therefore, the committee endorses studies that will provide (1) a basis for estimating the effectiveness of present flame and incendiary weapons and (2) guidelines for approaches to development of improved weapons of this type.

C.30. Doctrine for Employment of CB Weapons.

C&B weapons were suggested by many individuals for attack of cities. General concepts and type weapons utilizing these agents are currently available, but since neither lethal nor incapacitating C&B weapons have been employed, capabilities of present type weapons are not firmly evaluated, and tactics and doctrines for specific uses in attacks against cities are not available. Therefore, the group endorses the value of joint CDC-AMC studies to formulate tactics and doctrine (specifying all the critical parameters, such as meteorological and safety factors) that a commander would consider in choosing these weapons for the use of C&B weaponry in urban conflict. It is believed that such studies will provide the basis for developing improved tactics, doctrine, and C&B weapons.

C.31. Intelligence on the Urban Environment.

Extensive data on threats, targets, engagement conditions, and environments are acquired and analyzed by the Army to provide a basis for specifying and developing doctrine, organization, and materiel for land combat. Urban combat is a special case of land combat in which unique properties are highly sensitive to the physical characteristics of cities. A principal advantage of the city defender is his knowledge and exploitation of the concealment, protection, communication, and transportation features of the city, and of the attacker's ignorance of these features.

Three concurrent approaches for closing this information gap are recommended:

a. Catalog of City Characteristics:

Additional knowledge of the locations of critical targets and of the physical characteristics of cities of interest should give the attacker a better basis for the planning and execution

of his operations. Systematically planned collection of pertinent data coupled with the advancing technologies in information retrieval and communications should enable the realization of these advantages. (See further discussion in Appendix C.24.)

b. Combat Experimentation:

CDCEC experiments are performed to provide quantitative bases for development and evaluation of doctrine, organization, and materiel requirements for land combat. Similar experiments are required for the unique characteristics of urban areas. (See further discussion in Appendix C.1.)

c. Violence Incident Analyses:

Collect and analyze quantitiative information representing actual conflict in urban areas. Evaluate in terms of threat distribution, target characteristics, and engagement conditions--to provide a statistical basis for deducing effective combinations of operational doctrine and materiel characteristics. (See further discussion in Appendix C.25.)

C.32. Acoustic Holography.

There exists a slight possibility that the new field of holography can be used to examine the interior of rooms, search for sewers and tunnels and for other useful purposes. For this application the illuminating energy would necessarily be at acoustic wavelengths so as to penetrate the building, earth, or other substance which is opaque at visible wavelengths.

The tactical advantage given to the attacker if he were to know the location of rooms, hallways, and other structures within buildings before entry is self-evident. The study group does not, however, call for immediate and specific action on this problem in view of the current state of knowledge. It is believed that research in the principles of holography is progressing rapidly and that the role we envision for acoustic holography may be considered by some experts to be technically feasible at this time. However, the study group recognized that the signal processing problem for the application cited is exceedingly difficult and not likely to be solved in the immediate future. For these reasons, no recommendation for immediate action is made, although no implication is contained in the absence of explicit recommendation that exploration, investigation, and study of the use of holography in the urban combat context are unwarranted.

C.33. High Strength Materials.

Problem:

The Army is quite dependent upon strong materials for applications ranging from the load carrying frames of vehicles through the armor utilized to harden vehicles and extending into logistic applications such as portable bridges and other semi-permanent structures.

Concept:

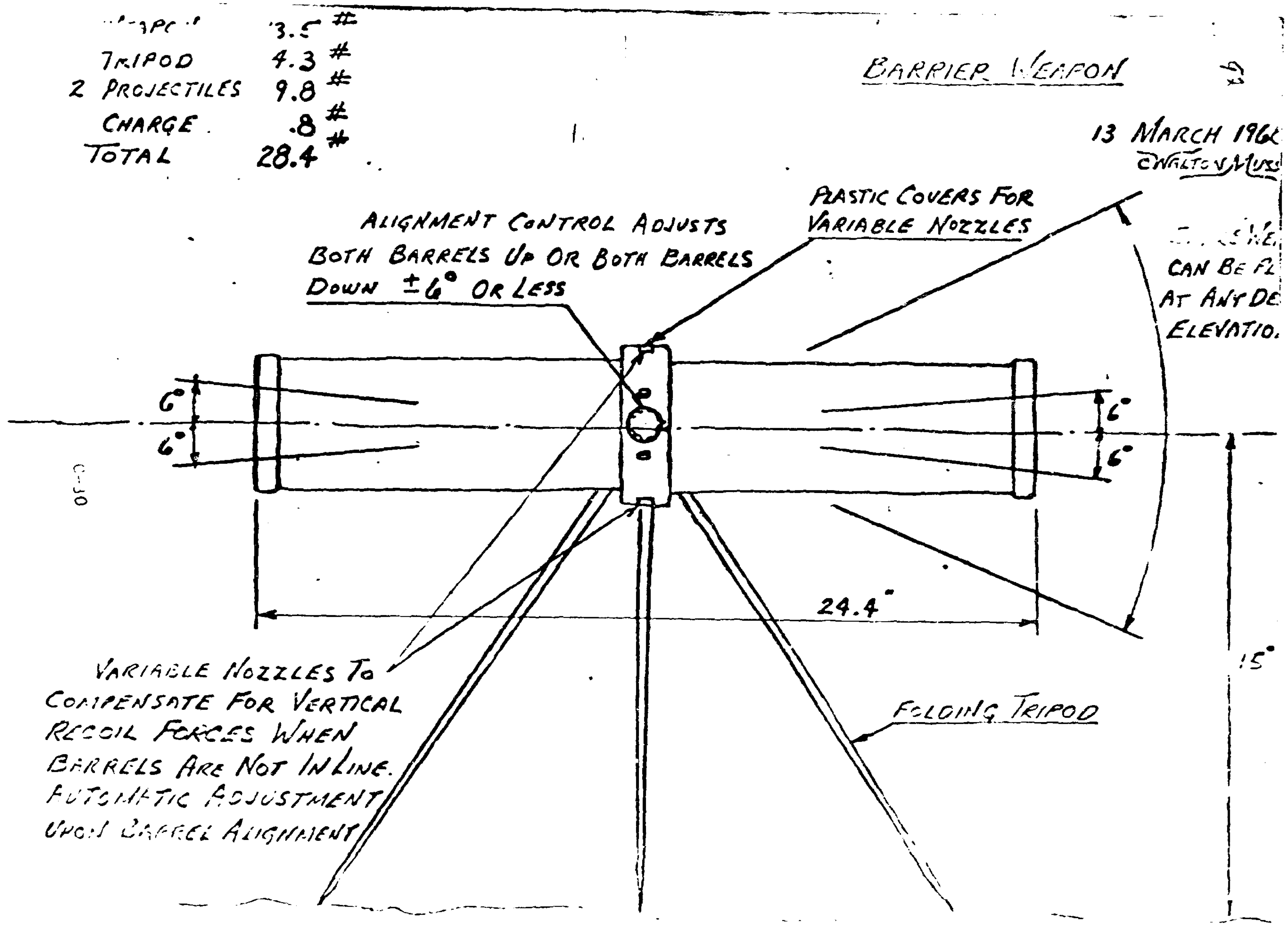
Inasmuch as the weight associated with strong structures tends to have a multiplicative factor with regard to the size of vehicles and the logistic problem and at the same time degrade mobility, it appears that the newly emerging technology based upon high strength, single crystal whiskers should have considerable application to the field army.

Tactical Employment:

The tactical employment for high strength materials has a variety of possible applications, many of which are presently highly speculative. Some of these are described in Appendix B, subsection 3.1.3.

Approach:

The Army should continue investigations of the applicability of new materials technology. It is recognized that the cost of such new materials may impede their full range of application, but it is expected that in time costs may decrease. In evaluating potential applications vis-a-vis costs, the detriments due to excessive weight and size should be carefully evaluated and should include, for example, all relevant costs such as the logistic cost of transporting excess bulk, the loss of mobility that results from excess bulk, and the cost of maintenance and battlefield failure resulting from unduly weak materials.



TRIPOD 4.3 #
2 PROJECTILES 9.8 #
CHARGE .8 #
TOTAL 28.4 #
BARRIER WEAPON
13 MARCH 196
ALIGNMENT CONTROL ADJUSTS BOTH BARRELS UP OR BOTH BARRELS DOWN ±6° OR LESS
PLASTIC COVERS FOR VARIABLE NOZZLES
CAN BE F
AT ANY DE
ELEVATIO
6°
6°
6°
6°
24.4"
15"
VARIABLE NOZZLES TO COMPENSATE FOR VERTICAL RECOIL FORCES WHEN BARRELS ARE NOT IN LINE. AUTOMATIC ADJUSTMENT UPON BARREL ALIGNMENT
FOLDING TRIPOD

Fig. 1

APPENDIX D - EXTRACTS, SUMMARY, AND DISCUSSION OF THE NATURE OF WAR IN URBAN AREAS

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APPENDIX D - EXTRACTS, SUMMARY, AND DISCUSSION OF THE NATURE OF WAR IN URBAN AREAS

D.1. Rationale of Urban Warfare.

In the attack of an urbanized area, the defender (enemy) has a number of advantages which he should exploit. On the other hand, not all aspects of urban fighting are advantageous to the defender. The purpose of the following discussion is to review some of the advantages and disadvantages of urban fighting as they pertain to the defender and the attacker.

If urban fighting is more difficult than combat in open terrain, it is appropriate to ask whether or not urban fighting is a necessary concomitant of modern warfare. The answer is probably yes; urban clearing is a needed capability, although some of the "historical" reasons for attacking fortified cities are no longer of direct applicability. The rationale of urban combat seems to be accurately expressed in the Army's field manual on combat in built-up areas.* The following excerpts from this manual provide useful guidelines for this review.

> "Built-up areas may become battle areas because their locations control routes of movement or because they contain valuable industrial or political installations."

From this same source we find the following considerations relating to the problems of defense of an urban area:

> "The use of a built-up area in the organization of a defense depends upon such factors as its size, its location in relation to the overall defensive mission, and whether it affords increased protection. Cities, towns, and villages constructed of flammable materials provide little protection and may become a hazard to the defender while buildings of masonry construction can be developed into well fortified defensive positions or strongpoints."

> "A built-up area that can be easily avoided has little defensive value. Thus, a built-up area suitable for defense must be located so that it forces an enemy to launch a direct attack or make a time-consuming maneuver."

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*Department of the Army Field Manual, "Combat in Fortified and Built-Up Areas," FM 31-50, Headquarters, Department of the Army, March 1964, Unclassified.

"The obstacle effect of built-up areas may permit their defense in lesser strength, thus providing economy-of-force."

"The defense of a built-up area is organized around key terrain features and centers of construction which preserve the integrity of the defense and provide ease of movement to the defender. Subterranean systems may be used for the movement of forces and may provide protection against nuclear attack--maximum use is made of rubble and other obstacles. Defenses are prepared in depth for continuous defense throughout the area."

"The man-made obstacles and cover characteristics of built-up areas favor the defender."

"Movement of vehicles is restricted to the narrow lanes provided by streets and alleys. Movement of foot troops is also confined, although some traffic through buildings is possible. Because of these difficulties in movement, the commitment of large, centrally controlled reserves for counterattacks within the built-up area usually is not feasible."

"Limited observation within the built-up area restricts both the attacker and the defender. Radio communication may be impeded by the buildings in the area."

Relative to the offense, the following characteristics are cited:

"The attacker has the advantage of maneuver in isolating the town or city to be seized. Once isolation has been completed, the attacker is in a position to either press the attack or to contain the defender and force him to capitulate."

"The attacker may select his point of entry into the built-up area. The attack may be conducted from any direction or from more than one direction."

"The attacker may be able to obtain a detailed plan of the built-up area to aid in planning his attack. Defectors or civilians may provide information to the attacker."

"The attacker may be able to by-pass strongly defended buildings by going under them, using cellars, sewers, subways, or other underground passages. Other

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strongly held defensive positions may be by-passed by attacking over the roofs of buildings."

The above listing of doctrine relative to offense and defense of urban areas might be restated as follows:

a. The buildings provide some measure of protection and concealment.

b. Fighting tends to be small-unit actions for both offense and defense. The defender's problems of committing reserves to shore-up weak points are magnified by problems of communication and control.

c. Both offense and defense will operate under decentralized control. Therefore, both doctrine and central planning must be emphasized in order to heighten operational effectiveness.

The apparent "preference" of the Army for nonurban combat is both stated in Army publications and implicit in the emphasis placed on the development of weapons and weapon systems best suited for employment in open country at brigade, division, and corps levels. Weapons and equipment providing long range mobility (and heavy firepower and requiring large crews to serve and maintain the equipment) are not a part of the weaponry of small units typically employed in urban warfare. Thus, as currently equipped and trained, the Army is using only a portion of its capacity when forced to fight on a house-to-house and block-to-block basis. Perhaps better weapons and equipment can be developed. Depending on the effectiveness of futuristic weapons, equipments, and tactics, the US Army might find urban wars preferable to wars fought in sparsely built-up regions.

From some tactical aspects, the question of Army preference for nonurban operations is moot; it may be necessary to seize and clear a city or town simply because it is in the way. On the other hand, tactical situations do arise in which a city or town may be either taken or by-passed. Given such an option in a war of attrition, the US Commander might properly attack the town if he estimated his exchange ratio (enemy loss/own loss) and other factors to be better in urban than in nonurban locales. For the reasons of tactical necessity and to equalize our own capability in urban and nonurban combat (and thereby eliminate our current preference for nonurban warfare), it appears that a new and continuing emphasis should be placed on developing weapons, equipments, and doctrine suited for city fighting.

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D.2. Specific Considerations.

D.2.1. Target Definition.

In urban combat, targets consist of troops and equipment in a locale characterized by a relatively high density of ordered man-made structures (e.g., buildings, roads, bridges, etc.) which can provide the defender with some measure of protection from weather, weapons fire concealment and channeled fields of fire.

D.2.2. Basic Military Objectives.

It may be desirable to neutralize or control an urban area for one or more of the following reasons:

a. It includes or provides a base for control of a portion of the existing lines of communication.

b. It contains materiel (such as stores of supplies or a production base) which may be captured for the attacker's use and/or to deny its use to the defender.

c. It has psychological and/or political value.

d. It is an actual or potential base for enemy military operations in the sense that it provides cover and concealment to enemy forces.

e. It contains enemy forces in being.

f. It contains noncombatant personnel which the attacking forces wish to control, capture, or liberate. (This objective would not apply to the present study which assumed the area to be void of noncombatants.)

D.2.3. Principal Operational Alternatives for Achieving the Military Objective.

Neutralization or control of a defended urban area can be achieved by one of the three following approaches:

a. By-pass and contain - The urban area is isolated. Containment is used to prevent enemy entry to or departure from the area, but no attempt is made by friendly forces to enter the area. Other military forces, if any, simply by-pass the contained area.

b. Neutralize without occupation - Enemy forces within the urban area are neutralized by some type of offensive action, but friendly forces do not (or cannot) enter the area immediately. Obvious methods of such neutralization may include selective obliteration of the area by nuclear weapons, fire storms, or the application of lethal

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or debilitating chemical, bacteriological or radiological agents over all or part of the area.

c. Seize and clear - Attacking forces enter and gain control of the whole urban area, clearing it of all enemy forces. The area is occupied by the attacking forces, even if only for a short time.

D.2.4. <u>Basis for Evaluation of Specific Operational/Materiel Concepts</u>.

In this study, the following criteria were established for the evaluation of operational/materiel concepts intended to improve the capability for achieving any of the specified operational alternatives:

a. <u>"Cost" Measurements.</u>

(1) Time.

(2) Friendly military casualties.

(3) Military material expenditures.

(4) Physical damage to the urban area.

(5) Noncombatant casualties.

b. <u>Effectiveness Measurements.</u>

It is desirable to evaluate effectiveness in terms of the degree of success achieved. However, no intermediate levels of success for the overall operation against the urban area can be defined. It is possible, of course, to deal with various degrees of success in achieving certain sub-goals of the overall operation (e.g., the fraction of enemy troops within a building which are incapacitated as a result of the application of a particular weapon). But within the value-judgment deliberations of this study, concepts were measured against only the qualitative interaction of the study group members. No attempt was made to quantify effectiveness arguments for or against any of the concepts, although these were intuitively present in the study group's thinking.

D.2.5. <u>General Description of Seizure and Clearance Operations</u>.

In the defended urban area, the enemy will have occupied and prepared alternate positions. Some or all of these positions may be extensively prepared for defense so that the attack may assume many of the characteristics of attack on a fortified area. The enemy will have established and will use to maximum effectiveness predetermined fields of fire which are well swept and integrated both in area overlap and weapon mix. These fields of fire will cover normal avenues of approach along with other active and passive barriers. The enemy will make maximum use

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of observational capability. Enemy cover and concealment will be excellent and will have an environmental background of man-made materials.

The first major phase of the full attack procedure is the approach march, which will include sweep of the area and neutralization, of the surrounding and outlying defensive positions. If possible, the defended urban area will be isolated by seizing terrain features dominating the approaches to it. As a minimum, the attacker must first secure positions outside the urban area from which he can support the entrance to it and the subsequent step-by-step capture of the objective. The fighting in this first phase normally will be of a form associated with rural areas and will not be considered further in this study.

The second phase of the operation will be an advance from the outside positions to seize a foothold in the urban area. During this portion of the operation, the attacking troops are quite vulnerable. The avenues of approach are limited at this point and will be blocked by both active and passive barriers. The troops will tend to be concentrated in areas which can most likely be well covered with enemy fire. On the other hand, during all or most of this action, the attack units can maintain reasonably good centralized control and hence can operate as a complete entity. The attacking troops will have available both direct and indirect support fire.

During this penetration phase, the attacking units may be forced to accept a higher risk of personnel losses and the expenditure of relatively large amounts of materiel to gain a foothold; it may also be necessary to accept a relatively high level of damage to the foothold portion of the urban area. During this part of the action it is evident that the attacking force must ascertain quickly and accurately the location of enemy strong points. At present the typical weapons used to defend these strong points include crew served weapons (e.g., mortars, recoilless rifles, rocket launchers, and rapid fire weapons) as well as machine guns and rifles.

The second and terminal phase of the attack consists of the advance from the foothold position(s) through the urban area to clear it of the enemy. This action is characterized by semi-independent operation of small units (perhaps squad size down to two or three-man teams) to accomplish the methodical clearance of assigned zones. This phase ends when the entire area has been cleared. In general, during this phase the attackers will be faced with the following disadvantages:

a. Loss of effective support from indirect fire weapons.

b. Centralized command, control and communications are difficult or impossible to maintain.

c. Normal areas of approach for the advance through the urban area are limited and partially predictable.

d. Sound and sight signatures of enemy defensive positions are garbled, making location of the positions by unaided human observation difficult.

e. The man-made structures which provide cover and concealment to the enemy also may impose high levels of background clutter for many sensors.

f. The number of possible defense positions is large compared to the number actually occupied.

g. The relative compactness of buildings and other structures make it possible for the enemy to reoccupy formerly cleared positions or to occupy sites previously investigated and found to be unoccupied.

h. Because of the relatively close range of combat, fleeting exposure and difficulty of identification of enemy targets, and the danger associated with exposure of the attacker's heavy weapons (e.g., tanks) within range of defended positions, there is little or no opportunity for the attacking troops to use anything but instantaneous fire. (Note that this factor is present in many forms of combat, but is accentuated in combat within defended urban areas.)

D.3. A Simple Mathematical Model of the Pace of Street Fighting. The discussion in this section is presented solely for its illustration of one type of mathematical model related to clearing a hostile town; no special credence for efficacy is intended.

Definition: "To besiege a place, is to surround it with an army and approach it by passages made in the ground, so as to be covered against the fire of the place . . . When the army can approach the town so near as to take it, without making any considerable works, the siege is called an attack."*

Thus, in modern warfare one is actually concerned with "attack" rather than "siege." The old approach to siege was to build a set of works comparable to those of the city, to close off supply routes, and by those two steps come to an advantageous posture relative to the enemy. Closing off supply routes remains an important tactic but the building of "works" has been largely rejected because of increases in mobility and firepower.

A crude analytic model of street fighting can be made if it is assumed (as is almost surely the case) that enemy tanks, major vehicles and large troop concentrations have been neutralized or dispersed by mines, mortars, and individual and crew-served direct fire weapons. Thus

*John Muller, The Attack and Defense of Fortified Places, 1791.

the situation is reduced to an infantry struggle, with rifles, machine guns, grenades, etc., being the major weapons.

Considering the engagement to consist of a multiplicity of one-on-one rifle duels,* it is apparent that if the probability of success for the attacker in any typical duel is p and the number of duels required to win the area is N, the attacker should expect (1-p)N casualties.

A rather favorable (to the attacker) value for p might be 1/3. If an area such as a typical city block of 10,000 m^2 requires 6 duels to seize, the attacker must expect to lose (dead and wounded) 4 men. The defender must expect to lose 2 men (dead and captured) but the four surviving defensive men can withdraw to augment the defenses of the remaining area.

If, within a small area such as a city block, these duels must be fought sequentially, it follows that the time required to search and clear a city block is approximately $rt_r + Nt_d$, where r is the number of rooms or other places of concealment within the area, t_r is the average time to search such places of concealment, N is the number of duels required to clear the area, and t_d is the average duration of the duel. If t_d is small (although this is not typically true at present), the time required to seize an area is nearly independent of the number of defenders; conversely, if t_d is large, the clearing rate is proportional to N (which is typically true).

One point evident from this discussion is that if new weapons and technology can significantly reduce t_d (and, with lesser impact on the outcome, also reduce t_r), the character of urban combat could be drastically changed. Both objectives seem achievable through technology.

There is no need, of course, to resort to the above arguments to conclude that a more favorable probability of winning the duel (i.e., a larger value for p) is the key objective. However, it appears that advanced technology is likely to decrease rather than increase p (for reasons which are touched on in the sections of this report which follow) and if this estimate is true, a capability to search quickly for and find the enemy and to consummate quickly any resulting duel becomes the

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*We shall assume that each duel consists of one rifleman facing one rifleman. If larger but equal units are engaged in the duel, the results we shall cite do not precisely apply. If the opposing multiple-man units are dissimilar in size, the problem becomes even more complex and our simplistic example is even less valid. These are but a few of the reasons why this analytic model is considered to be very crude but the reader may find this discussion satisfactory, if he accepts the proposition that, in the limit, the urban combat problem tends to reduce to man-to-man fighting.

principal objective. Hopefully, the tactical commander can use this potentially available speed of search and seizure of urban areas so that he may use tactical surprise to minimize and reduce the unfavorable (for the attacker) exchange ratio (p) this study group anticipates for future urban wars.

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13. ABSTRACT

This study lists advanced materiel concepts for neutralizing or controlling a defended urban area which is void of non-combatants and which consists of a high density, ordered, city-like structures. This study was conducted with recognition of the constraints of accomplishing a combat mission in minimum time, with minimum friendly casualties, minimum cost and minimum incidental damage to the urban area.

The study scope included description of seizure and clearance operations in which future friendly forces seek to occupy the urban area and engage in conflict with well-trained and organized enemy regulations. Thirty-eight ideas for enhancing urban conflict of the future were derived and discussed. Typical of these ideas were: a small controllable air reconnaissance devices, large volume quick hardening foams, personnel carrier assault vehicle designed for urban environment and a remote control expendable ground reconnaissance vehicle.

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